

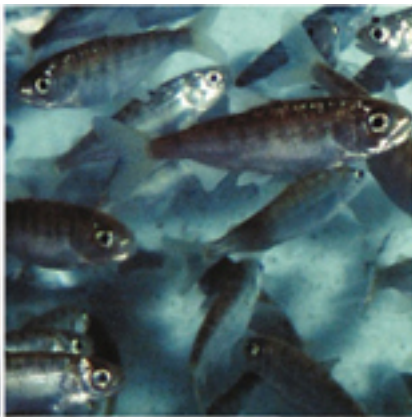
Habitat Evaluation Procedures (HEP) Report

Ladd Marsh

Technical Report 2001

October 2001

DOE/BP-00004656-2



This Document should be cited as follows:

Unknown, "Habitat Evaluation Procedures (HEP) Report; Ladd Marsh", 2001 Technical Report, Project No. 200002100, 83 electronic pages, (BPA Report DOE/BP-00004656-2)

Bonneville Power Administration
P.O. Box 3621
Portland, OR 97208

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

LADD MARSH WILDLIFE AREA ADDITIONS MITIGATION PROJECT



ASSESSMENT OF BASELINE HABITAT CONDITIONS USING HABITAT EVALUATION PROCEDURES (HEP)

Project Number 2000-021-00

Contract Number 00004656

**Prepared for:
The Bonneville Power Administration**

**Prepared by:
The Oregon Department of Fish and Wildlife**

October 1, 2001

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES.....	ii
INTRODUCTION	1
SITE DESCRIPTION	2
Historical Background	2
Current Conditions.....	2
Wallender Property	3
Simonis Property.....	3
Conley Lake Property	3
Becker Property	4
BASELINE HABITAT COVER TYPES	4
Agland (637.29 acres).....	4
Riparian scrub-shrub (40.52 acres).....	5
Emergent wetland (160.1 acres)	5
Grassland (16.6 acres).....	5
Disturbed Areas (3.81 acres).....	5
HABITAT EVALUATION PROCEDURES (HEP).....	8
MODEL SELECTION.....	9
Yellow Warbler.....	10
Ring-necked Pheasant.....	10
California Quail	11
Canada Goose	12
METHODS	13
Yellow Warbler.....	15
Ring-necked Pheasant.....	15
California Quail	15
Canada Goose	15
Others.....	15
RESULTS AND DISCUSSION.....	16
Wallender Parcel.....	16
Ring-necked pheasant	16
Yellow warbler.....	17
California Quail	17
Simonis Parcel	18
Ring-necked pheasant	18
Yellow warbler.....	18
California quail	18
Canada goose	19

Conley Lake Parcel	19
Ring-necked pheasant	19
California Quail	19
Canada goose	20
Becker Parcel	20
Ring-necked pheasant	20
Yellow warbler.....	20
California quail	21
Canada goose	21
SUMMARY	21
REFERENCES	22

LIST OF FIGURES AND TABLES

Figure 1. Vegetation cover types on Wallender, Simonis and Becker parcels of the Ladd Marsh Wildlife Area Additions mitigation project. The Simonis acreages exclude the city wetwell area.	6
Figure 2. Vegetation cover types on the Conley Lake Parcel of the Ladd Marsh Wildlife Area Additions mitigation project.....	7
Table 1. Matrix of target species and cover types relevant to baseline and future Ladd Marsh HEP analyses	10
Table 2. Model Variables and HSI equation for yellow warbler	10
Table 3. Model variables and HSI equation for ring-necked pheasant.....	11
Table 4. Model variables and HSI equation for California quail.....	12
Table 5. Model variables and HSI equation for Canada goose.....	13
Table 6. Variables and sampling methods used in the Ladd Marsh project area HEP analysis.....	14
Table 7. Acres by parcel and model results for Ladd Marsh Additions HEP analysis.....	16

LIST OF APPENDICES

Appendix A. HSI models for selected target species for the Ladd Marsh Wildlife Area Additions HEP analysis
Appendix B. Baseline HEP data analysis

INTRODUCTION

Since the mid-1980s, the Oregon Department of Fish and Wildlife (ODFW) has been participating in the Bonneville Power Administration's (BPA's) efforts to mitigate for the negative impacts to fish and wildlife resulting from the development and operation of the Columbia Basin Federal Hydropower System. BPA's mitigation obligations were formally recognized and mandated by the Northwest Power Act of 1980 and are guided by the Northwest Power Planning Council's (NWPPC's) Columbia Basin Fish and Wildlife Program. BPA funds fish and wildlife projects throughout the Basin to meet the habitat and population restorative goals and objectives outlined in the NWPPC's Fish and Wildlife Program and to fulfill its mitigation responsibilities under the Power Act.

Impacts to wildlife resulting from hydrofacility construction/inundation were estimated using Habitat Evaluation Procedures (HEP) in the mid and late 1980s and are documented in BPA's Wildlife Loss Assessments (Rasmussen and Wright 1990,a,b,c,d) and in the U.S. Army Corps of Engineers Lower Snake River Wildlife Habitat Compensation Evaluation (ACOE 1991). The loss assessments provided estimates of lost habitat quality and quantity for the target species selected to represent the habitat cover types impacted by hydropower construction/inundation. The NWPPC incorporated these losses into their Fish and Wildlife Program, recognizing them as the unannualized losses attributable to the construction/inundation of the federal hydropower system (NWPPC 1995 and 2000, Table 11-4). The HEP methodology is used by wildlife managers within the Columbia Basin to determine habitat values, expressed as Habitat Units, gained through BPA-funded mitigation project work.

ODFW and the other Oregon wildlife managers (i.e., U.S. Fish and Wildlife Service, Confederated Tribes of the Warm Springs Reservation of Oregon, Burns Paiute Tribe, and Confederated Tribes of the Umatilla Indian Reservation [CTUIR]) have been working together since 1991 to coordinate the planning, selection, and implementation of BPA-funded wildlife mitigation projects. In 1997, the Oregon wildlife managers developed a programmatic project for mitigation planning and implementation within Oregon. The Ladd Marsh Wildlife Area Additions project is one of many habitat acquisition and restoration projects proposed under the Oregon wildlife managers' programmatic project that have been approved and recommended for funding by the NWPPC.

The Ladd Marsh Wildlife Area Additions mitigation project will protect and restore wetland, riparian and other habitats on newly acquired parcels at ODFW's Ladd Marsh Wildlife Area (LMWA). Wildlife habitat values resulting from the acquisition and enhancement of Ladd Marsh Wildlife Area lands will contribute towards mitigating for habitat lost as a result of the development and operation of the Columbia Basin hydropower system.

This report summarizes the HEP survey conducted in June 2001 to document the baseline habitat values on four parcels recently added to the Ladd Marsh Wildlife Area: the 309.66-acre Wallender property, the 375.54-acre Simonis property, the 161.07-acre

Conley Lake property, and the 74.55-acre Becker property. The 2001 HEP Team was comprised of the following members and agencies: Susan Barnes (ODFW), Allen Childs (CTUIR), Tracy Hames (Yakama Indian Nation), Dave Larson (ODFW), Cathy Nowak (Cat Tracks Wildlife Consulting), and Ken Rutherford (ODFW). Results of the HEP will be used to 1) determine the pre-restoration habitat values of the project sites, 2) the number of Habitat Units to be credited to BPA for protection of habitats within the project area, 3) determine the enhancement potential of the sites, and 4) develop a habitat management plan for the area.

SITE DESCRIPTION

Historical Background

The Ladd Marsh Wildlife Area is located approximately eight miles southeast of La Grande, Oregon, in the heart of the Grande Ronde Valley and near the eastern base of the Blue Mountains. Prior to settlement, the entire Grande Ronde Valley had an estimated 30,000 to 40,000 acres of wetlands. The area was historically known as Tule Lake. Human activity since settlement has continually reduced the amount of wetlands in the valley so it could be used for agricultural and grazing purposes. By 1948, extensive drainage of the Tule Lake wetland complex left only about 500 acres of original wetland. The first land purchase to protect the remaining wetland occurred soon after and the LMWA was designated by ODFW. Today, the Tule marsh located on the LMWA is the largest remnant wetland in northeast Oregon.

Current Conditions

The LMWA lies within the floodplains of Ladd, Barney, and Catherine Creeks and presently totals 4,128 acres, including the four recently incorporated properties. It is managed to provide a variety of quality habitats for a myriad of species. Habitat types include grain fields, tree and shrub areas and native prairie, as well as marsh and open waters. About 0.75 mile of Middle Fork Ladd Creek and 0.25 mile of Barney Creek are channelized to permit agricultural development. Both of these streams run parallel to gravel roads with little or no meander. The riparian channels are bounded by willow and cottonwood trees, as well as by introduced grasses and weeds. Wet meadow and grassy uplands provide safe nesting areas for birds, grain fields serve as feeding areas for migratory waterfowl, and hayfields provide winter feed for deer and elk. The LMWA has over 200 species of birds, 40 species of mammals and 13 species of amphibians, which spend all or part of their life cycle on the marsh. The Middle Fork of Ladd Creek is home to resident rainbow and steelhead trout. Steelhead populations in the Grande Ronde Basin are listed as Threatened under the Federal Endangered Species Act for the entire Snake River Basin. The following sensitive, threatened and endangered species also occur on or near the LMWA: bald eagle (*Haliaeetus leucocephalus*; Federally Threatened), bobolink (*Dolichonyx oryzivorus*; State Sensitive, Vulnerable), greater sandhill crane (*Grus canadensis tabida*; State Sensitive, Vulnerable), Swainson's hawk (*Buteo swainsoni*; State Sensitive, Critical), painted turtle (*Chrysemys picta*; State

Sensitive, Critical), and summer steelhead (*Oncorhynchus mykiss*; Federally Threatened) and spring Chinook salmon (*Oncorhynchus tshawytscha*; Federally Threatened).

Wallender Property

The 309.66-acre Wallender parcel is located north of the existing Ladd Marsh Wildlife Area in Section 32, Township 3 South, Range 39 East and in Section 29, Township 3 South, Range 39 East. The property has been degraded by past agricultural and grazing practices, and water diversion efforts. Wetlands have been drained and converted to agricultural land. Prior to purchase by The Nature Conservancy for ODFW in 1998, the Wallender parcel was farmed for small grain and alfalfa production. Most of the property (295.49 acres) is currently idle farmland and pasture. Two water sources, Ladd Creek and Barney Creek, flow through the property and have been channelized next to county roads to accommodate agricultural and road construction. Much of the parcel is subject to periodic flooding from the Middle Fork Ladd Creek, which runs along the southern and eastern property boundaries, and from Barney Creek, which flows through the Simonis property and existing LMWA land to the south. Barney Creek joins with Middle Fork Ladd Creek on the southern boundary of the Wallender parcel.

309.66

Simonis Property

The Simonis property is 375.54 acres within the corners of Section 33 of Township 3 South, Range 39 East, Section 4 of Township 4 South, Range 39 East, and Section 5 of Township 4 South, Range 39 East. The land is east of Highway 203 and a Union Pacific Rail Road line. Peach Road nearly splits the parcel east and west, and current LMWA land lies adjacent to the Simonis parcel to the north and west. Approximately 62.5 acres in the northwest corner of the 375-acre property have been eased to the City of La Grande for development and management of a city wet well/sewage treatment pond. The facility will provide a supply of nutrient rich supplemental water to the LMWA. Presently, a 279.81-acre mosaic of pasture, alfalfa, grass hay, and small grain, collectively characterized as agland, exist on the property. A residence allotment and right-of-way totaling 3.81 acres is located in the northeast portion of the project area. Scattered seasonal wetlands totaling 21.6 acres contribute to periodic flooding. Barney Creek flows north through the parcel and joins with the Middle Fork Ladd Creek at the Wallender property boundary. Barney Creek was relocated to a ditch in the early 1900s to accommodate agriculture, ranching, and road construction. The 62.5-acre piece being eased by the City of La Grande is not considered part of the Ladd Marsh BPA project area, thus was not included in the HEP baseline habitat survey.

375.54

Conley Lake Property

The Conley Lake parcel is approximately 161.07 acres located in the northeast corner of Township 2 South, Range 39 East, Section 35. It is about 8 miles east of La Grande on Cover Road. It is bounded by agricultural land (wheat and crop grass) on all sides.

161.07

This parcel is comprised of 99.08 acres of emergent wetland and associated wetland, and 61.99 acres of uplands, presently yielding small grains and mint. Farming historically occurred within a few feet of the wetland. There is a small band of native vegetation separating the wetland from surrounding agricultural land. The wetland is shallow (2-3 feet when full) and often dries up by late summer or early fall. Fall moisture and lower evaporation rates enable the lake to fill again. It is an extremely important migration area for waterfowl and shorebirds. The area also provides nesting and rearing habitat for wetland birds. In recent years, prior landowners have made attempts to drain and farm the area. During drier years, the wetland was pumped to allow farming and haying.

Becker Property

74.55
Although the Becker property totals approximately 480 acres, only 74.55 acres are included in the Ladd Marsh BPA mitigation project. The City of La Grande currently owns the Becker property and is easing 74.55 acres to ODFW in exchange for the easement on Simonis. The Becker parcel is north of Wilkinson Road and adjacent to the northeast corner of the Wallender property. It is located in the NW corner of Section 28, Township 3 South, Range 39 East. Ladd Creek flows northeast through the property from the southwest corner of the parcel. About 18.53 acres of riparian scrub-shrub habitat are associated with Ladd Creek, as well as 39.42 acres of seasonal wetlands. The 16.6 acres of grassland that occur on the property have been grazed in the past.

BASELINE HABITAT COVER TYPES

859.32
219
The Ladd Marsh Wildlife Area project site is characterized by four major habitat types (**Figure 1** and **Figure 2**): agland (637.29 acres), emergent wetland (160.1 acres), riparian scrub-shrub (40.52 acres) and grassland (16.6 acres). Total acreage for all habitat types is 916.97 acres.

Agland (637.29 acres)

This habitat type is common throughout the project area. It consists of agricultural cropland or grazed pastureland. Annual crops primarily include spring wheat, alfalfa, and barley. Other non-native grasses and forbs occur such as bulbous bluegrass (*Poa bulbosa*), tall wheatgrass (*Thinopyrum ponticum*) and kochia (*Kochia scoparia*). Non-native, invasive species in this habitat type include cheat grass (*Bromus tectorum*), thistle (*Cirsium* spp.), whitetop (*Cardaria draba*) and bachelor button (*Centaurea cyanus*), among others. There are 295.49 acres of this habitat type on the Wallender property, 279.81 acres on the Simonis property (excluding the city wet-well area) and 61.99 acres on the Conley Lake property. It is absent from the Becker parcel. Although agland on the Wallender parcel has been grazed in the past, it has not been grazed in recent years. Approximately 30 percent of the Wallender property was hayed in 2001. Although none of the Simonis agland west of Peach Road has been recently mowed, 80 percent of the agland cover type east of Peach Road has been hayed annually, with about half receiving

its first cutting before July 15. The agland on the Conley Lake property has not, typically, been mowed before July 15.

Riparian Scrub-Shrub (40.52 acres)

This habitat type occurs in a narrow band adjacent to Ladd Creek on the Wallender (14.17 acres) and Becker (18.53 acres) properties and along irrigation/drainage ditches on the Simonis property (7.82 acres). It is absent from the Conley Lake parcel. The habitat is dominated by coyote willow (*Salix exigua*) and other willows (*Salix* spp.) less than 15 feet (4.6 m) in height. Scattered trees such as black willow (*Salix nigra*), a non-native species likely introduced during early settlement of the area, black cottonwood (*Populus trichocarpa*) and a small stand of aspen (*Populus tremuloides*) occur near Peach Road on the Wallender property. Shrub species include wild rose (*Rosa woodsii*, *R. nutkana*), black hawthorn (*Crataegus douglasii*) and red-osier dogwood (*Cornus stolonifera*). Grasses and sedges include reed canary grass (*Phalaris arundinacea*), wiregrass (*Juncus* spp.) and saltgrass (*Distichlis* spp.).

Emergent Wetland (160.1 acres)

This habitat type covers much of the southern two-thirds of the Becker parcel (39.42 acres), a small portion of the south half of the Simonis parcel east of Peach Road (21.6 acres) and most of the Conley Lake property (99.08 acres). The species present vary by parcel including: tules (*Typha latifolia*), sedges (*Carex* spp.), reed canary grass, saltgrass, three-square bulrush (*Scirpus americanus*), hardstem bulrush (*S. acutus*), orchard grass (*Dactylis glomerata*), rushes (*Juncus* spp.) and sedges (*Carex* spp.). Water depths in the wetlands of the project area seldom exceed 30 inches (76 cm). Greatest water depth usually occurs during spring runoff. Minimum water depth occurs in late summer/early fall; Conley Lake is often dry at this time.

Grassland (16.6 acres)

This habitat type occurs only in the northwest corner of the Becker property (16.6 acres); there is no grassland habitat type on any of the other properties. It is characterized by intermediate wheatgrass (*Agropyron intermedium*), tall wheatgrass, cheat grass (*Bromus tectorum*), meadow foxtail (*Alopecurus pratensis*) and scattered rabbitbrush (*Chrysothamnus nauseosus*). Poor soil and annual flooding have prevented cultivation of this portion of the property in the past.

Disturbed Areas (3.81 acres)

This area is located near the north boundary of the Simonis property and includes a house, several outbuildings and access from Peach Road.

Ladd Marsh Wildlife Area Additions

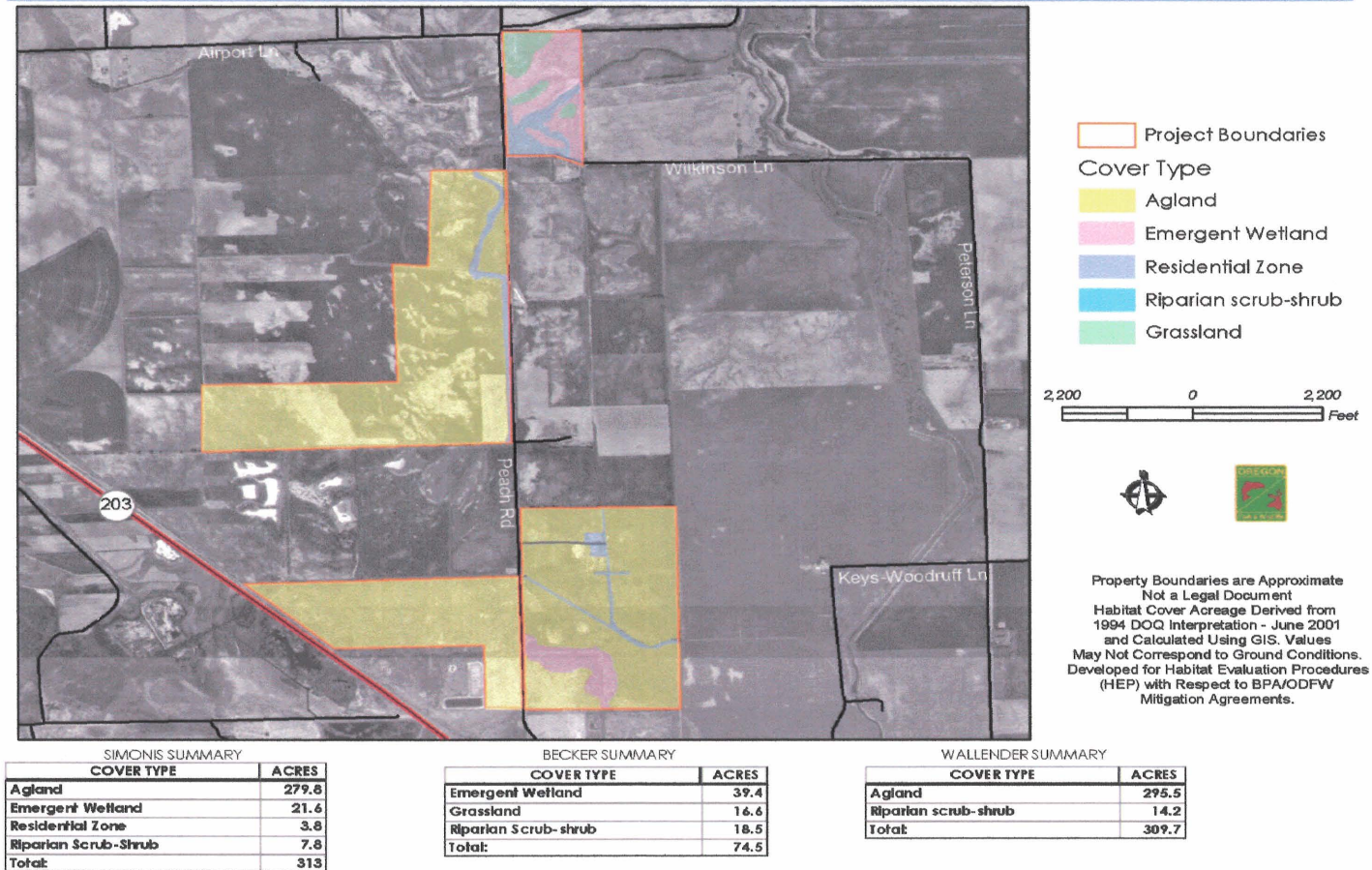


Figure 1. Vegetation cover types on Wallender, Simonis and Becker parcels of the Ladd Marsh Wildlife Area Additions mitigation project. The Simonis Agland cover type acreage excludes the city wetwell area.

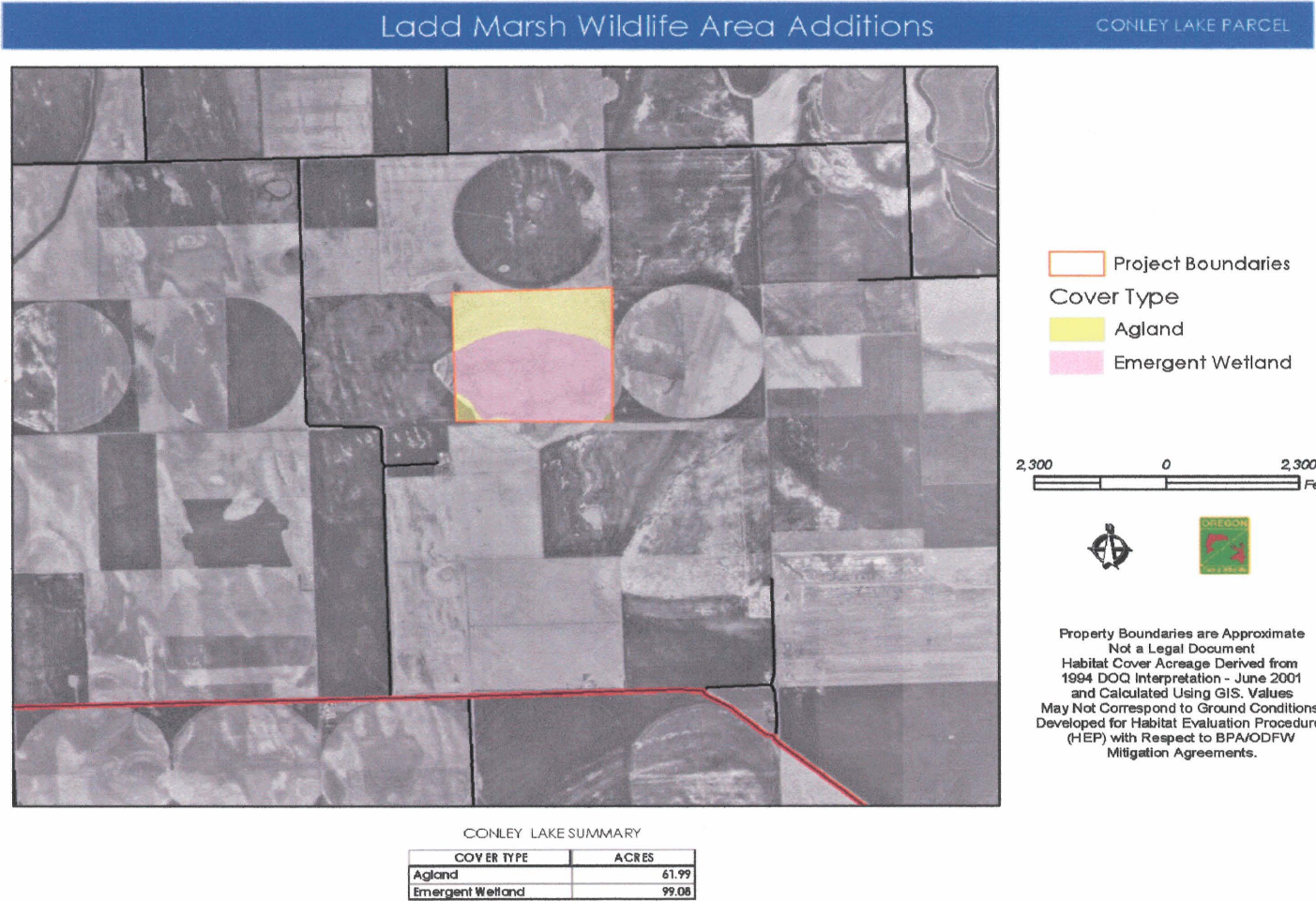


Figure 2. Vegetation cover types on the Conley Lake Parcel of the Ladd Marsh Wildlife Area Additions mitigation project

HABITAT EVALUATION PROCEDURES (HEP)

HEP is an outgrowth of the 1969 National Environmental Policy Act (NEPA), which required all federal agencies to employ systematic and interdisciplinary techniques in planning and decision-making. HEP, developed by the U.S. Fish and Wildlife Service (USFWS) in 1980, uses a species/habitat approach for quantifying relative habitat values. It is useful in project planning because it provides both objectivity and repeatability. HEP assumes:

- That it is possible to quantify habitat values by describing a set of measurable habitat variables that are important for the species;
- There is a direct relationship between habitat and potential population;
- This relationship can be expressed as an index;
- Habitat suitability can be predicted with some degree of biological certainty.

To apply HEP, several wildlife species are selected for a particular area. Each species has various habitat needs that are documented in a Habitat Suitability Index (HSI) model. HSI models focus primarily on the measurement of physical and chemical habitat variables which are used to calculate index to habitat quality. The model includes information on habitat use, model structure, assumptions, applications, and references.

The habitat in a study area is compared to optimum habitat (defined in the HSI model) for a species to result in a HSI. The HSI is a number between 0 and 1:

0 represents no habitat suitability

1 represents optimum habitat suitability

The HSI is multiplied by the area or amount (e.g., number of acres) of a particular habitat in the study area to obtain Habitat Units (HUs).

$$\text{HSI} \times \text{Area (e.g., Acres)} = \text{HUs}$$

1 Habitat Unit = 1 acre with optimum habitat suitability

For selected species whose habitat resources are provided in more than one cover type, the composition of the different resources was important in determining habitat suitability. Composition refers to the relative proportion of the potential habitat that provides the necessary habitat resources. Under ideal conditions, the resources required by the species were balanced in regard to the needs of the selected species. To calculate the overall HSI for these multi-cover type dependent species, the relative amount of the cover types providing specific resources was determined. This was done for each cover type providing a life requisite by comparing its area to the total area of habitat as follows:

$$\text{Relative composition of cover type X} = \frac{\text{Area of cover type X}}{\text{Total area of all cover types used by the species}} \times 100$$

The relative area calculations by cover type are then summed for each life requisite and an Equivalent Optimal Area (EOA) suitability index is determined for each life requisite. The life requisites values are then compared to determine an overall HSI value, generally considered to be the lowest life requisite value.

MODEL SELECTION

The HEP Team selected the following target species to determine the value of existing and potential wildlife habitats at the Ladd Marsh Wildlife Area project area:

Target Species

Yellow warbler (*Dendroica petechia*)
 Song sparrow (*Melospiza melodia*)
 Ring-necked pheasant (*Phasianus colchicus*)
 California quail (*Callipepla californica*)
 Canada goose (*Branta canadensis*)
 Downy woodpecker (*Picoides pubescens*)

The HEP Team considered all the Lower Snake River loss assessment species that are amended into the NWPPC's FWP (ACOE 1991; NWPPC 2000), as well as alternate Canada goose models used for the loss assessments of the lower four Columbia River dams (Rasmussen and Wright 1990a,b,c,d). Target species were selected based on the habitat types and characteristics that are currently present in the project area, habitat types and characteristics that are expected to occur post-restoration activity, and the number of target species used to represent each cover type in the original loss assessment. Habitat use in relation to food, reproduction, cover requirements, and season of use was also considered in the species selection process.

Each of the parcels was then assigned species from the species list mentioned above according to the presence of current and anticipated habitat types. The following matrix (Table 1) displays selected target species and represented cover types within the project area.

Table 1. Matrix of target species and cover types relevant to baseline and future Ladd Marsh HEP analyses

Species	Cover Type					
	Riparian Forest*	Riparian Scrub-Shrub	Emergent Wetland	Open Water*	Grassland	Agland
Yellow warbler		X				
Song Sparrow	X					
Ringed-necked pheasant	X	X	X			X
California quail	X	X			X	X
Canada goose			X	X		X
Downy woodpecker	X					

* Riparian forest and open water cover types are not currently present but are expected to occur under future management

Yellow Warbler

The yellow warbler model (Schroeder 1982a) was used to evaluate riparian scrub-shrub areas. Moderate shrub densities (60 to 80 percent) of at least 6.5 feet (2 m) in height are considered optimal. The presence of hydrophytic shrubs (e.g., willow, alder) increases the value of the riparian scrub-shrub habitats. Model variables and HSI equation are shown in Table 2.

Table 2. Model Variables and HSI equation for yellow warbler

Variable (V)	Suitability Index (SI)
V1 = percent deciduous shrub crown cover (live only)	SI = 1.0 if between 60% and 80%
V2 = average height of deciduous shrub canopy (live only)	SI = 1.0 if > 2 m
V3 = percent of deciduous shrub canopy comprised of hydrophytic shrubs	SI = 0.1 to 1.0 if 0% to 100%
$HSI = (SIV1 * SIV2 * SIV3)^{1/2}$	

Ring-necked Pheasant

The ring-necked pheasant was selected to evaluate the riparian scrub-shrub, emergent wetland, and agland cover types. The model used by the ACOE and originally developed by the former Soil Conservation Service (SCS 1988) was used after it was slightly modified by the LMWA HEP Team. The model evaluates nesting cover, winter cover, and winter food. Nesting conditions in non-agland cover types are considered optimum when canopy cover of 50 to 90 percent with an herbaceous height of at least 24 inches (60 cm) exists. Mowing frequency prior to July 15 determines optimum nesting conditions in agland areas. Winter cover is considered optimum when canopy cover of

persistent vegetation is 30 to 60 percent. Proximity to preferred food also affects winter cover suitability. The value of winter food is determined by the cover type; all cover types except emergent wetland are assumed to have varying degrees of food value and are ranked accordingly. The HSI for the ring-necked pheasant is based on the Equivalent Optimal Area (EOA) methodology and equals the minimum suitability indice (SI) for the three life requisite (LR) EOAs. Model variables and HSI equation are shown in Table 3.

Table 3. Model variables and HSI equation for ring-necked pheasant

Variable (V)	Suitability Index (SI)
Reproduction LR	
V1 = % herbaceous canopy cover	SI = 1.0 if between 50% and 90%
V2 = average height of herbaceous canopy	SI = 1.0 if between 60 cm and 80 cm
V3 = Mowing category during nesting season	SI = 1.0 if not mowed; 0.3 if mowed before July 15; 0.0 if mowed frequently
LRSI (non-agland) = $(SIV1 * SIV2)^{1/2}$	
LRSI (agland) = V3	
LR EOA $\geq 80\%$ of habitat area (optimum)	
Winter Cover LR	
V1 = % canopy of persistent winter vegetation (> 0.5 m)	SI = 1.0 if between 30% and 60%
V2 = Distance to winter food	SI = 1.0 if <200m; 0.0 if > 800m
LRSI = SIV1 * SIV2	
LR EOA $\geq 30\%$ of habitat area (optimum)	
Winter Food LR	
V1 = Winter food type	SI = 1.0 if agland; 0.3 if riparian scrub/shrub; 0.3 if grassland; 0.0 if emergent wetland
LRSI = SIV1	
LR EOA $\geq 50\%$ of habitat area (optimum)	
Overall HSI = minimum SI for LR EOAs	

California Quail

The California quail was selected to evaluate the riparian scrub-shrub, grassland, and agland cover types at the LMWA project area. The quail model (USFWS 1985a) for the Lower Snake assessment was used. The model considers food, escape cover, and winter roost cover. Food availability in all cover types is affected by distance to both escape cover and winter roost cover. The percent of herbaceous canopy cover is used as an index of food availability in non-agland cover types. Herbaceous canopy cover and height, shrub canopy cover and height and distance to winter roost cover affect the quality of escape cover. Shrub canopy cover and height are considered important indicators of winter roost habitat quality. The HSI for the California quail is based on the Equivalent Optimal Area methodology and equals the minimum suitability indice for the three life requisite EOAs. Model variables and HSI equation are shown in Table 4.

Table 4. Model variables and HSI equation for California quail

Variable (V)	Suitability Index (SI)
Food LR	
V1 = Distance to escape cover	SI = 1.0 if < 50 m; 0.0 if >150 m
V2 = Distance to winter roost cover	SI = 1.0 if < 320 m; 0.0 if > 480 m
V3 = % herbaceous canopy cover	SI = 1.0 if between 25% and 75%
LRSI (agland) = Minimum of SIV1 or SIV2	
LRSI (other cover types) = (Minimum of SIV1 or SIV2) * (0.75 * SIV3)	
LR EOA \geq 40% of habitat area (optimum)	
Escape Cover LR	
V1 = % herbaceous canopy	SI = 1.0 if between 50% and 100%
V2 = average height of herbaceous canopy	SI = 1.0 if > 61cm
V3 = % canopy of shrubs <6 m in height (live and dead)	SI = 1.0 if > 20%
V4 = average height of shrubs < 6 m in height	SI = 1.0 if > 1 m
V5 = Distance to roost cover	SI = 1.0 if < 320 m; 0.0 if >480 m
LRSI = [Maximum of (SIV1 * SIV2) ^{1/2} or (SIV3 * SIV4) ^{1/2}] * SIV5	
LR EOA \geq 20% of habitat area (optimum)	
Winter Roost Cover LR	
V1 = % canopy of shrubs <6m in height	SI = 1.0 if > 20%
V2 = average height of shrubs < 6m in height	SI = 0.2 if 1 m; 1.0 if > 1.5 m
V3 = Distance to escape cover	SI = 1.0 if < 320 m; 0.0 if >480 m
LRSI = (SIV1 * SIV2) ^{1/2} * SIV3	
LR EOA \geq 10% of habitat area (optimum)	
Overall HSI = minimum SI for LR EOAs	

Canada Goose

The Canada goose was selected to evaluate the quality of shoreline and island habitat in the LMWA project area. Existing goose models that were considered are intended for rivers and reservoirs with islands present. The absence of moving water and islands at the LMWA necessitated a modification of the existing models (USFWS 1985b and USFWS 1990). Habitat is assumed to be at least marginally suitable if geese presently nest there. The degree of suitability is determined based on criteria from the model such as distance to open water, vegetation height, and distance to suitable foraging areas. Model variables and HSI equation are shown in Table 5.

Table 5. Model variables and HSI equation for Canada goose

Variable (V)	Suitability Index (SI)
V1 = Nesting Habitat / Cover	SI = 0.8-1.0 if islands present & cover 4" to 8" high; 0.5-0.7 if islands present and cover >8" or <4"; 0.0-0.4 if no islands present or islands with no or limited cover
V3 = Brood Rearing Habitat	SI = 0.7 – 1.0 if forage area <1 mile from nest area, ≥ 1 -ac, ≤ 25 m from open water and forage $\leq 4''$ tall; 0.4-0.6 if distance ≥ 1 & ≤ 2 miles, ≥ 1 -ac, 25-50 m from open water and $\leq 4''$ tall; 0.0-0.3 if > 2 miles from nesting area and > 50 m from open water
<i>HSI = Average of SIV1 and SIV3</i>	

METHODS

An interdisciplinary team conducted the baseline HEP to document the existing value of various habitats on the Wallender, Simonis, Conley Lake and Becker parcels on June 11 and 12, 2001. The HEP team consisted of Susan Barnes (ODFW), Allen Childs (Confederated Tribes of the Umatilla Indian Reservation), Tracy Hames (Yakama Nation), David Larson (ODFW), Cathy Nowak (Cat Tracks Wildlife Consulting) and Ken Rutherford (ODFW).

Prior to the HEP survey, habitat types were delineated on all four properties using geographical analysis techniques. This included geographic information systems (GIS), orthophotography interpretation, coordinate geometry (COGO) input, geographic positioning system (GPS) integration, and local and historical knowledge. Acreages of each cover type were calculated. Several meetings were held with a smaller core team, plus the USFWS and BPA, to identify cover types, select target species, discuss the models chosen and their applicability, determine which sampling methods would be used and decide where sampling would occur.

Habitat data was collected along 300-ft (100 m) transects with sampling locations spaced 25 feet (8.3 m) apart. Aerial photography was used to select the general location of transects in each cover typed polygon. Actual transect starting points were determined on the ground by the HEP Team. A GPS location was taken at most starting points. At the starting point, one team member held a transect tape while another walked to the length of the tape. The tape was placed on the ground. All except one 100 m transect remained within the cover type polygon. In this exception, additional tape length was laid out in another polygon of the same cover type to complete the sampling area. Field data was collected using a variety of sampling techniques. For example, percent shrub cover was measured using the line intercept methodology and a graduated rod was used to measure shrub height. Several variables were measured within a plot frame which was placed on one side of the transect at 8.3 m intervals. Some variables were determined using GIS

technology (e.g., distance measurements) and ocular estimation was used for some variables (e.g., herbaceous cover). A more complete list of sampling methods for each variable is shown in Table 6.

Table 6. Variables and sampling methods used in the Ladd Marsh project area HEP analysis

Variable	Sampling Method
% shrub canopy cover	Line intercept – number of shrub “hits” on the meter tape
Mean height of shrub canopy	Graduated rod and ocular estimate
% shrub canopy cover comprised of hydrophytic shrubs	Note if shrub “hit” is hydrophytic species. Record species. Include willows, locust, cottonwood, alder, and olive
% herbaceous canopy cover	Record percent cover of non-grass and non-woody vegetation within plot frame perpendicular to transect at 8.3m intervals. Record to nearest 5%. If there are any forbs present at least 5% is recorded.
Mean height of herbaceous canopy	Measure height (in cm) of herbaceous canopy within each plot frame using meter stick and ocular estimate
% canopy cover of persistent winter cover (>.5 m tall)	Record percent cover of any vegetation within plot frame perpendicular to transect of any vegetation that remains standing (even plant skeletons)
Distance to winter food (Winter Food = agland, forbland, mesic shrubland)	Measure distance (in m) from randomly selected points using GIS to edge of nearest winter food cover type.
Winter Food Type	If agland SI = 1.0; If grassland SI = 0.3, If riparian s/s SI = 0.3
Distance to escape cover (Escape cover = mesic shrubland, rip. forest, rip s/s, shrubsteppe low & high, forbland, but NOT agland)	Measure distance (in m) from randomly selected points using GIS to edge of nearest escape cover type.
Distance to roost cover (Roost cover = mesic shrubland, rip. forest, rip. s/s, shrub steppe high)	Measure distance (in m) from randomly selected points using GIS to edge of nearest roost cover type.
Cropland plowed or mowed before July 15 (nesting season)	If not mowed, SI = 1.0 If mowed, SI = 0.3 If mowed often, SI = 0
% cover of goose forage	Ocular estimate of suitable goose forage cover on a side transect perpendicular to the main transect. Start cover estimates at the edge of the suitable nesting area and then at 8.3 m intervals out to 100 m from the shoreline
Mean height of vegetative canopy	Measure height (in cm) of vegetation using a Robell pole at 8.3 m intervals

Yellow Warbler

For the yellow warbler model, habitat was evaluated along two 100 m line transects in the riparian scrub-shrub cover type at Wallender, two 100 m transects in the riparian scrub-shrub cover type at Simonis and two 100 m transects in the riparian scrub-shrub cover type at Becker. The Conley Lake property lacks the riparian scrub-shrub cover type; thus, the yellow warbler model was not used at Conley Lake.

Ring-necked Pheasant

For the ring-necked pheasant model, habitat was evaluated along two 100 m transects in the riparian scrub-shrub cover type, at four randomly selected points in the agland cover type, and with GIS and local knowledge at Wallender; two 100 m transects in riparian scrub-shrub, eight randomly selected points in the agland cover type, one 100 m transect in the emergent wetland cover type, and with GIS and local knowledge at Simonis; two 100 m transects in riparian scrub-shrub, two 100 m transects in emergent wetland, and with GIS and local knowledge at Becker; two 100 m transects in emergent wetland, four randomly selected points in the agland cover type, and with GIS and local knowledge at Conley Lake.

California Quail

For the California quail model, habitat was evaluated along two 100 m transects in the riparian scrub-shrub cover type and using GIS and local knowledge at Wallender; two 100 m transects in riparian scrub-shrub and using GIS and local knowledge at Simonis; two 100 m transects in riparian scrub-shrub, one 100 m transect in the grassland cover type, and using GIS and local knowledge at Becker; and using GIS and local knowledge at Conley Lake.

Canada Goose

For the Canada goose model, habitat was evaluated along one 100 m transect in the agland cover type at Simonis; two 100 m transects in the emergent wetland cover type at Becker; and one 100 m transect in emergent wetland and one 100 m transect in agland at Conley Lake. Measurements taken along transects included vegetation height and density. GIS analysis was used to determine the distance from nesting to foraging areas and from foraging areas to open water. The amount of suitable habitat in each parcel was determined based on historic use by geese and local knowledge of the area. There is no known use of the Wallender parcel for nesting by geese; therefore, the Canada goose model was not used at Wallender.

Others

The models for the downy woodpecker (Schroeder 1982b) and song sparrow (USFWS 1979) were considered but not used for any of the four properties because the cover types associated with those species in the Lower Snake River Wildlife Habitat Evaluation

the low SI score. The area of riparian scrub-shrub is expected to increase with future management, which will likely increase the suitability of this parcel for pheasant.

Yellow warbler

The yellow warbler was selected to evaluate riparian scrub-shrub habitats on the Wallender. Shrub/tree species present were willows, water birch, rose, black hawthorn and dogwood. There was a small stand of aspen near the road. The total area of riparian scrub-shrub was 14.17 acres. Habitat in this cover type was evaluated along two transects. An HSI was calculated for each transect and then the two were averaged. The highest HSI return for this parcel was in the northeast corner where a dense patch of willows has taken over. Shrub crown cover was low along both transects contributing to a relatively low HSI return in both cases. Additionally, shrub species on the first transect were nearly all roses, a non-hydrophytic taxa, resulting in an SI of 0.1 for V3₁. Thus, species composition of the riparian scrub-shrub cover type limits the quality of this habitat for yellow warbler. Future management is expected to increase the depth and duration of flooding on some areas of this parcel, which would encourage the spread of hydrophytic shrubs and trees and its value to yellow warblers.

<u>Variable</u>	<u>Transect 1</u>	<u>Transect 2</u>
V1 = percent deciduous shrub canopy cover	V1 ₁ = 21%	V1 ₂ = 28%
V2 = average height of deciduous shrub canopy	V2 ₁ = 1.02 m	V2 ₂ = 2.66 m
V3 = percent shrubs hydrophytic	V3 ₁ = <1%	V3 ₂ = 100%
Where $HSI = (V1 * V2 * V3)^{1/2}$	HSI ₁ = 0.12	HSI ₂ = 0.67
Overall HSI = 0.4, HUs = 5.67		

California Quail

Habitat suitability for California quail was evaluated in both the agland and riparian scrub-shrub cover types. The total area of suitable habitat was 309.66 acres. The lowest suitability index score was for the LR of food in the agland cover type (0.0). This was because of long average distances to escape and roost cover, making it unsafe for quail to feed in these areas. This contributed to a low overall SI for food (0.033). Clean farming and overgrazing have reduced brushy fencerows, weedy patches, and similar brushy edges that offer escape and roost cover. Habitat suitability for quail in the riparian scrub-shrub was moderate to high but the low relative area of this cover type kept the overall SI scores low. Suitability is expected to increase under future management as native vegetation replaces crop species and shrub areas increase in size. The model will measure the increase in upland improvements. The HSI equals the lowest of the Equivalent Optimal Area suitability indices for the life requisites of food (LRSI = 0.033), escape cover (LRSI = 0.23) and winter roost (LRSI = 0.359). Therefore, the HSI = 0.033 and HUs total 10.22.

Simonis Parcel

Ring-necked pheasant

The ring-necked pheasant was used to represent agland, riparian scrub-shrub, and emergent wetland habitats totaling 309.23 acres. The riparian scrub-shrub habitat on this parcel is less than optimum for reproduction (LRSI = 0.62), winter cover (LRSI = 0.023) and winter food (LRSI = 0.3). This is largely due to low density and height of herbaceous vegetation and low density of persistent winter vegetation. The agland cover type is relatively high quality for reproduction (LRSI = 0.783) and optimum for winter food (LRSI = 1.0). Most of the agland (69 percent) on the property was not mowed and the rest (31 percent) was mowed infrequently and not before nesting season, improving the chances of brood success. The emergent wetland cover type was optimum (LRSI = 1.0) for winter cover but the low relative area of this type reduced its impact on the overall HSI. Winter cover was the most limiting factor for pheasant on this parcel due to the low score for this LR the riparian scrub-shrub and the low relative area of the habitat types that provide this cover. The HSI equals the lowest of the Equivalent Optimal Area suitability indices for the life requisites of reproduction (LRSI = 0.905), winter cover (LRSI = 0.235) and winter food (LRSI = 1.0). Therefore, the HSI = 0.235 and HUs total 72.67.

Yellow warbler

The yellow warbler model was used to evaluate riparian scrub-shrub habitats on the Simonis parcel. Total area of suitable habitat was 7.82 acres. Shrub/tree species present were willows, water birch, rose, black hawthorn and dogwood. Habitat in this cover type was evaluated along two transects. An HSI was calculated for each transect and then the two were averaged. On one transect, shrubs less than 18 ft (6 m) were absent resulting in a HSI for that transect of 0.0. Habitat suitability along the second transect was nearly optimal (0.92). Clean farming and overgrazing have reduced brushy fencerows, weedy patches, and similar brushy edges that may provide habitat for yellow warbler. Habitat suitability is expected to increase with future management as shrub patches are allowed to flourish.

<u>Variable</u>	<u>Transect 1</u>	<u>Transect 2</u>
V1 = percent deciduous shrub crown cover:	V1 ₁ = 0.0%	V1 ₂ = 88%
V2 = average height of deciduous shrub canopy:	V2 ₁ = 0.0 m	V2 ₂ = 3.23 m
V3 = percent shrubs hydrophytic:	V3 ₁ = 0.0%	V3 ₂ = 100%
Where $HSI = (V1 * V2 * V3)^{1/2}$	HSI ₁ = 0.0	HSI ₂ = 0.92
Overall HSI = 0.46, HUs = 3.6		

California quail

Habitat suitability for California quail was evaluated in both the agland and riparian scrub-shrub cover types. The total area of these cover types was 287.63 acres. The

lowest suitability index score was for the LR of food in the agland cover type (0.0). This was because of long average distances to escape and roost cover, making it unsafe for quail to feed in these areas. This contributed to a low overall SI for food (0.014). Clean farming and overgrazing have reduced brushy fencerows, weedy patches, and similar brushy edges that offer escape and roost cover. Habitat suitability for quail in the riparian scrub-shrub was moderate to high but the low relative area of this cover type kept the overall SI scores low. Suitability is expected to increase under future management as native vegetation replaces crop species and shrub areas increase in size. The model will measure the increase in upland improvements. The HSI equals the lowest of the Equivalent Optimal Area suitability indices for the life requisites of food (LRSI = 0.014), escape cover (LRSI = 0.077) and winter roost (LRSI = 0.135). Therefore, the HSI = 0.014 and HUs total 4.03.

Canada goose

Habitat suitability for Canada goose was evaluated in the agland cover type; total area of suitable habitat was 39.86 acres. Geese are known to nest on this property (D. Larson, pers. comm. 2001). However, based on the model habitat suitability is assumed to be less than optimum (i.e., there are no islands). Therefore, V1 = 0.5 (no islands present, but nesting takes place); V3 = 0.3 (>50m to open water but ditches provide passage corridors to open water, vegetation < 4 inches tall, forage area >1 acre and ≥ 10 acres of forage within 1 mile of nesting area). The HSI equals the average of suitability indices for the life requisites of nesting (0.5) and foraging (0.3). Therefore, the HSI = 0.4 and HUs total 15.94. Creation of wetlands with future management will reduce the distance to open water and create greater security for nesting and foraging geese.

Conley Lake Parcel

Ring-necked pheasant

The pheasant was selected to assess agland and emergent wetland habitats on the Conley Lake parcel (totaling 161.07 acres). The agland cover type was optimum, according to the model, for reproduction and winter food. Winter cover in the emergent wetland area was the factor limiting habitat suitability for Canada goose on this parcel. The low density of persistent winter vegetation (11.54 percent cover) resulted in a low SI for that variable and a relatively low overall HSI for the property. The HSI equals the lowest of the Equivalent Optimal Area suitability indices for the life requisites of reproduction (LRSI = 0.48), winter cover (LRSI = 0.79) and winter food (LRSI = 0.77). Therefore, the HSI = 0.48 and HUs total 77.31.

California quail

Habitat suitability for California quail was evaluated in the agland cover type (61.99 acres). No suitable escape or roost cover is available on the Conley Lake parcel or within 408 ft (136 m) of the parcel boundaries, thus, making it unsafe for quail to forage there.

Clean farming and overgrazing on and adjacent to the Conley Lake parcel have eliminated brushy fencerows, weedy patches, and similar brushy edges that might offer such cover. Thus, this parcel was totally unsuitable for quail at the time of the HEP. Suitability is expected to increase under future management. The model will measure the increase in upland improvements. The HSI equals the lowest of the Equivalent Optimal Area suitability indices for the life requisites of food (LRSI = 0.148), escape cover (LRSI = 0.0) and winter roost (LRSI = 0.0). Therefore, the HSI = 0.0 and HUs total 0.0.

Canada goose

Habitat suitability for Canada goose was evaluated in the agland and emergent wetland cover types. The total area of suitable habitat is 14.95 acres. Geese are known to nest on this property (D. Larson, pers. comm. 2001). However, based on the model habitat suitability is assumed to be less than optimum (i.e., there are no islands). Therefore, V1 = 0.3 (no islands present, but nesting takes place); V3 = 1.0 (<25 m to open water, vegetation < 4 inches tall, forage area >1 acre and ≥ 10 acres of forage within 1 mile of nesting area). The HSI equals the average of suitability indices for the life requisites of nesting (0.3) and foraging (1.0). Therefore, the HSI = 0.65 and HUs total 7.06. Restoration of native vegetation in the uplands on this site may improve forage and cover for geese and increase the area of suitable habitat on the parcel.

Becker Parcel

Ring-necked pheasant

The pheasant model was used to evaluate the emergent wetland and riparian scrub-shrub habitats, totaling 57.95 acres, on the Becker property. Although the SI for winter cover in the emergent wetland cover type is low (0.015), this is offset by the high relative area of the type (68 percent). The factor most limiting habitat suitability for pheasant on this parcel is winter food (overall LRSI = 0.19). Given that the agland cover type is absent from the parcel, riparian scrub-shrub would be the source of winter food. Riparian scrub-shrub is given a relatively low SI in the model (0.3) and accounts for less than a third of the property (32 percent). The HSI equals the lowest of the Equivalent Optimal Area suitability indices for the life requisites of reproduction (LRSI = 0.2), winter cover (LRSI = 0.76) and winter food (LRSI = 0.19). Therefore, the HSI = 0.19 and HUs total 11.01.

Yellow warbler

The yellow warbler model was used to evaluate the 18.53 acres of riparian scrub-shrub habitat that occur on the Becker property, primarily along Ladd Creek. Shrub/tree species present were willows, water birch, rose, black hawthorn and dogwood. An HSI was calculated for each of two transects and the results averaged to obtain the overall HSI for this species. The percent canopy cover of shrubs was low on one transect but all other variables indicated optimum habitat suitability for yellow warbler.

<u>Variable</u>	<u>Transect 1</u>	<u>Transect 2</u>
V1 = percent deciduous shrub canopy cover:	V1 ₁ = 23.0%	V1 ₂ = 77%
V2 = average height of deciduous shrub canopy:	V2 ₁ = 2.08 m	V2 ₂ = 2.18 m
V3 = percent shrubs hydrophytic:	V3 ₁ = 100%	V3 ₂ = 100%

Where $HSI = (V1 * V2 * V3)^{1/2}$

HSI₁ = 0.62 HSI₂ = 1.0

Overall HSI = 0.81, HUs = 15

California quail

Habitat suitability for California quail was evaluated in the grassland and riparian scrub-shrub habitats, which totaled 35.13 acres. Nearly half of the parcel contains suitable habitat for quail. Habitat suitability was generally high for quail although the mean distance to escape cover 504 ft (168 m) reduced the value of the grassland for forage to zero. The grassland cover type was also unsuitable for the LR of escape cover (LRSI = 0.0) due to the absence of shrub cover and low mean height of herbs. The riparian scrub-shrub was generally high quality for quail, however, and contributed to a relatively high overall HSI. Nevertheless, suitability is expected to increase under future management with changes in the composition of the grassland habitat to more native species and increased density of woody species. The model will measure the increase in upland improvements. The HSI equals the lowest of the Equivalent Optimal Area suitability indices for the life requisites of food (LRSI = 0.75), escape cover (LRSI = 1.0) and winter roost (LRSI = 1.0). Therefore, the HSI = 0.75 and HUs total 26.35.

Canada goose

Habitat suitability for Canada goose was evaluated in the emergent wetland cover type. Geese are known to nest on this property (D. Larson, pers. comm. 2001). However, based on the model habitat suitability is assumed to be less than optimum (i.e., there are no islands). Therefore, V1 = 0.1 (no islands present, little nesting takes place); V3 = 0.5 (<50 m to open water during nesting season as Ladd and Catherine creeks seasonally flood pastures, vegetation < 4 inches tall, forage area >1 acre and ≥ 10 acres of forage within 1 mile of nesting area). The HSI equals the average of SIs for the LRs of nesting (0.1) and foraging (0.5). Therefore, the HSI = 0.3 and HUs total 3.26.

SUMMARY

The Ladd Marsh Wildlife Area Additions mitigation project site is presently made up mostly of agricultural and pasture land with smaller areas of riparian scrub-shrub, emergent wetland, and grassland cover types. The four parcels in the BPA mitigation project area support a variety of fish and wildlife, including the four HEP target species selected to evaluate habitat values prior to restoration activity. The Wallender parcel provides very poor habitat for ring-necked pheasant and California quail, good habitat for yellow warbler, and no habitat for Canada goose. The Simonis parcel provides marginal habitat for ring-necked pheasant, poor habitat for California quail, and moderate habitat

for yellow warbler and Canada goose. No habitat for the yellow warbler occurs on the Simonis parcel due to the absence of the riparian scrub-shrub cover type. The Becker parcel provides poor habitat for pheasant, good habitat for quail, near optimal habitat for yellow warbler, and marginal habitat for Canada goose.

A total of 281.23 Habitat Units currently exist on the project area. Future restoration and management, which will be described in a Five-Year Habitat Management Plan, are expected to change the configurations and proportions of habitat types at the Ladd Marsh Wildlife Area Additions project site. Restoration activities are expected to create new emergent wetland, open water, riparian scrub-shrub, and riparian forest habitats. The amount of agriculture and pastureland habitat will decline as these wetland habitats are restored. This project will help BPA offset the wildlife losses associated with the construction/inundation of the Lower Snake River hydroprojects and will be consistent with the Northwest Power Planning Council's Columbia Fish and Wildlife Program mitigation goals.

REFERENCES

- ACOE. 1991. Special Report: Lower Snake River fish and wildlife compensation, wildlife habitat compensation evaluation for the Lower Snake River project. U.S. Army Corps of Engineers, Walla Walla District. 59 pp plus appendices.
- Larson, D. 2001. Personal communication between David Larson (ODFW) and Cathy Nowak (Cat Tracks Wildlife Consulting) on September 21, 2001.
- NWPPC. 1995. Columbia River basin fish and wildlife program, Northwest Power Planning Council.
- NWPPC. 2000. Columbia River basin fish and wildlife program. Northwest Power Planning Council, Portland, OR. Doc. No. 2000-19. 55 pp plus appendices.
- Rasmussen, L. and P. Wright. 1990a. Wildlife impact assessment, Bonneville Project, Oregon and Washington. Prepared by the U. S. Fish and Wildlife Service for the U.S. Dept. of Energy, BPA, Portland, Oregon. 37 pp.
- Rasmussen, L. and P. Wright. 1990b. Wildlife impact assessment, McNary Project, Oregon and Washington. Prepared by the U. S. Fish and Wildlife Service for the U.S. Dept. of Energy, BPA, Portland, Oregon. 46 pp.
- Rasmussen, L. and P. Wright. 1990c. Wildlife impact assessment, John Day Project, Oregon and Washington. Prepared by the U. S. Fish and Wildlife Service for the U.S. Dept. of Energy, BPA, Portland, Oregon. 47 pp.
- Rasmussen, L. and P. Wright. 1990d. Wildlife impact assessment, The Dalles Project, Oregon and Washington. Prepared by the U. S. Fish and Wildlife Service for the U.S. Dept. of Energy, BPA, Portland, Oregon. 34 pp.
- Schroeder, R. L. 1982a. Habitat suitability index models: yellow warbler. U.S. Fish and Wildlife Serv. Biological Report. USFWS/OBS-82/10.27. 8 pp.
- Schroeder, R. L. 1982b. Habitat suitability index models: downy woodpecker. U.S. Fish and Wildlife Serv. Biological Report. USFWS/OBS-82/10.27. 7 pp.

- SCS. 1988. North Whitsan pheasant habitat suitability index model (modified). Soil Conservation Service (now the Natural Resource Conservation Service), Washington.
- USFWS. 1979. Draft song sparrow habitat suitability index model. (modified). Unpublished review copy.
- USFWS. 1980. Habitat evaluation procedures (HEP). U.S. Fish and Wild. Serv. Ecol. Serv. Manual 102. Div. Ecol. Serv., Washington, D.C.
- USFWS. 1985a. Habitat suitability index model: California quail. U.S. Fish and Wildlife Serv., Sacramento, California.
- USFWS. 1985b. Wildlife impact assessment, Palisades Project. Canada geoses HSI model. (Modified for Lower Snake River Project).
- USFWS. 1990. Canada goose model. Page 36 of Rasmussen and Wright 1990c. Canada goose model HSI model (modified for the John Day Dam Wildlife Impact Assessment).

APPENDIX A

HSI Models for Selected Target Species for the Ladd Marsh Wildlife Area Additions Mitigation Project HEP Analysis

LOWER SNAKE HSI FORMULAS

SONG SPARROW

$$\begin{aligned} \text{HSI} &= \text{Min.} \left/ \begin{array}{l} (\text{SI VCVSH01} \times \text{SI VHTSH01})^{1/2} \\ \text{SI SDIPW01} \end{array} \right. \\ &= \text{Min.} \left/ \begin{array}{l} (\text{V1} \times \text{V2})^{1/2} \\ \text{V3} \end{array} \right. \end{aligned}$$

YELLOW WARBLER

$$\begin{aligned} \text{HSI} &= (\text{SI VCVSH02} \times \text{SI VHTSH05} \times \text{SI VRCCK01})^{1/2} \\ &= (\text{V1} \times \text{V2} \times \text{V3})^{1/2} \end{aligned}$$

DOWNY WOODPECKER

$$\begin{aligned} \text{HSI} &= \text{Min.} \left/ \begin{array}{l} \text{SI VBAW001} \\ \text{SI VDN3ND3} \end{array} \right. \\ &= \text{Min.} \left/ \begin{array}{l} \text{V1} \\ \text{V2} \end{array} \right. \end{aligned}$$

MARSH WREN

$$\begin{aligned} \text{HSI} &= (\text{SI GWTHEM} \times \text{SI VCVEM01} \times \text{SI WDFEM01})^{1/3} \times \text{SI VCVTR07} \\ &= (\text{V1} \times \text{V2} \times \text{V3})^{1/3} \times \text{V4} \end{aligned}$$

CANADA GOOSE

$$\begin{aligned} \text{HSI} &= \text{Min.} \left/ \begin{array}{l} \text{SI ISLI} \\ \text{SI BRHAB} \end{array} \right. \\ &= \text{Min.} \left/ \begin{array}{l} \text{V1} \\ \text{V2} \end{array} \right. \end{aligned}$$

CHUPAR

$$\begin{aligned} \text{HSI} &= \text{Min.} \left/ \begin{array}{l} (\text{SI VCVHE01}^2 \times \text{SI VCVSH01})^{1/3} \\ (\text{SI VCVHE01} \times \text{SI VCVSH01})^{1/2} \end{array} \right. \times \text{Min.} \left/ \begin{array}{l} \text{SI DISTRO0} \\ \text{SI DISTM0} \\ \text{SI ST001} \end{array} \right. \\ &= \text{Min.} \left/ \begin{array}{l} (\text{V1}^2 \times \text{V2})^{1/3} \\ (\text{V1} \times \text{V2})^{1/2} \end{array} \right. \times \text{Min.} \left/ \begin{array}{l} \text{V3} \\ \text{V4} \\ \text{V5} \end{array} \right. \end{aligned}$$

RING-NECKED PHEASANT

$$\text{LRSI (REPRO 1)} = (\text{SI VCVHE01} \times \text{SI WHITE01})^{1/2}$$
$$= (\text{V1} \times \text{V2})^{1/2}$$

$$\text{LRSI (WTRCVR)} = \text{SI CANTWIN} \times \text{SI DSTWFO}$$
$$= \text{V1} \times \text{V2}$$

$$\text{LRSI (WTRFOD)} = \text{FOODCT}$$
$$= \text{V1}$$

$$\text{LRSI (REPRO 2)} = \text{MCWJUN}$$
$$= \text{V1}$$

COVER TYPE ACREAGE = RELATIVE AREA
TOTAL ACRES

LR LSI

$$\text{SUM}(\text{RELATIVE AREA} \times \text{HSI}) = \text{LR EOA} \times \text{EOA}$$

$$\text{OVERALL HSI} = \min. \begin{cases} \text{LR REPRO EOA} \\ \text{LR WTRCVR EOA} \\ \text{LR WTRFOD EOA} \end{cases}$$

WHITE DEER

$$\text{HSI} = \frac{3(\text{SI VCVSH07} \times \text{SI CVSHOP})^{1/2} \times \text{SI VCVHE01}}{4}$$
$$= \frac{3(\text{V1} \times \text{V2})^{1/2} \times \text{V3}}{4}$$

} In ea cont
then weight by
area (like CREOA =
Sum (relative area x HSI))

WESTERN MEADOWLARK

$$\text{HSI} = \frac{\sqrt{\text{SI VCVHE01} \times \text{SI VRCGR01} \times \text{SI WHITE03} \times \text{SI SCIPS01} \times \text{SI VCVSH01}}}{4}$$
$$= \sqrt{\text{V1} \times \text{V2} \times \text{V3} \times \text{V4} \times \text{V5}}$$

CALIFORNIA QUAIL

$$LRSI (FOOD 1) = \min. \begin{cases} SI DISTESC \\ SI DISTEST \end{cases}$$

$$= \min. \begin{cases} V1 \\ V2 \end{cases}$$

$$LRSI (FOOD 2) = (SI VCVHSC1 \times .75) \times \min. \begin{cases} SI DISTEST \\ SI DISTESC \end{cases}$$

$$= (V1 \times .75) \times \min. \begin{cases} V2 \\ V3 \end{cases}$$

$$LRSI (ESC.CVR.) = SI DISTEST \times \max. \begin{cases} (SI VCVHSC1 \times SI VHTHSC1)^{1/3} \\ (SI VCVSH01 \times SI VHTSH01)^{1/3} \end{cases}$$

$$= V5 \times \max. \begin{cases} (V1 \times V2)^{1/2} \\ (V3 \times V4)^{1/2} \end{cases}$$

$$LRSI (WTR.RST) = (SI VCVHSC1 \times SI VHTSH01)^{1/2} \times SI DISTESC$$

$$= (V1 \times V2)^{1/2} \times V7$$

$$\frac{\text{COVER TYPE ACREAGE}}{\text{TOTAL ACRES}} = \text{RELATIVE AREA}$$

$$\text{SUM}(\text{RELATIVE AREA} \times \text{LRSI}) = \text{LR EOA} \times 100$$

$$\text{OVERALL HSI} = \min. \begin{cases} \text{LR FOOD EOA} \\ \text{LR ESC CVR EOA} \\ \text{LR WTR RST EOA} \end{cases}$$

RIVER OTTER

$$HSI = (SI DISTCVR \times SI DISTCVR \times SI DENSITE)^{1/3}$$
$$= (V1 \times V2 \times V3)^{1/3}$$

MALLARD

$$HSI = SI HUMDIST \times SI CVRSECR$$

$$= V1 \times V2$$

Library: D:\LSNAKE.HLB
3-10-1990

Single coverytype model.

Model name: YELLOW WARBLER

Verification level: EXPERT REVIEW
Creation/modification date: 3-6-1990

SCHROEDER, R.L. 1982. HABITAT SUITABILITY INDEX MODELS:
YELLOW WARBLER. U.S. FISH WILDL. SERV. BIOL. REP.
FWS/OBS-82/10.27. 7 PP.
Applies to breeding.
Range: throughout the breeding range of the species.

Covertypes:

PSS : Palustrine scrub/shrub wetland

Lev 3	Lev 2	Lev 1
VCVSH02	grf	usf-HSI
VHTSH05	grf-----	
VRCSH01	grf-----	

Habitat variables:

VCVSH02 : Percent canopy cover of deciduous shrubs (i.e., <8m tall) (%)
VHTSH05 : Mean height of deciduous shrub canopy (not of individual shrubs) (m)
VRCSH01 : % of deciduous shrub canopy cover : hydrophytic species (%)

GRAPH FUNCTION at level 2, position 1

Title: % DECIDUOUS SHRUB CROWN COVER

X:	0.000,	Y:	0.000
X:	60.000,	Y:	1.000
X:	80.000,	Y:	1.000
X:	100.000,	Y:	0.600

GRAPH FUNCTION at level 2, position 2

Title: AVERAGE HEIGHT OF SHRUB CANOPY (M)

X:	0.000,	Y:	0.000
X:	2.000,	Y:	1.000
X:	5.000,	Y:	1.000

GRAPH FUNCTION at level 2, position 3

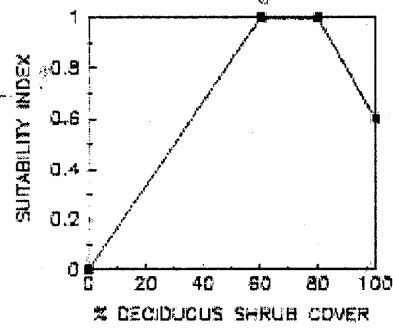
Title: % SHRUB CANOPY COMPRISED OF HYDROPHYTIC SHRUBS

X:	0.000,	Y:	0.100
X:	100.000,	Y:	1.000

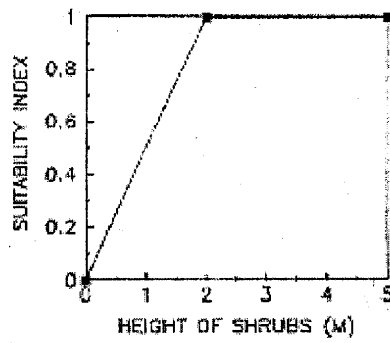
USER-SPECIFIED FUNCTION at level 1, position 1

USUD = (X(1)*X(2)*X(3))^{0.5}

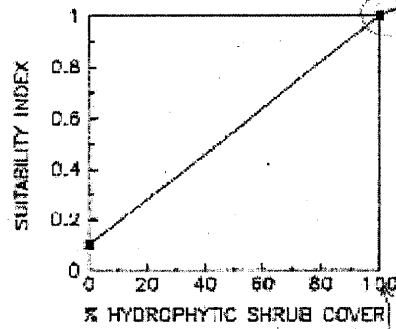
YELLOW WARBLER VCVSH02



YELLOW WARBLER VHTSH05



YELLOW WARBLER VRCSH01



Library: D:\LSNAKE.HLD
3-10-1990

Single coverytype model.

Model name: DOWNY WOODPECKER

Verification level: EXPERT REVIEW
Creation/modification date: 10-12-1989

SCHROEDER, N. L. 1982. HABITAT SUITABILITY INDEX MODELS:
DOWNY WOODPECKER. U.S. FISH WILDL. SERV. BIOL. REP.
FWS/OBS-82/10.38. 10 PP.
Range: throughout the species' range.

Covertypes:

PFC : Palustrine forested wetland

Lev 3	Lev 2	Lev 1
VBAW001--grf-----min--H3I		
VDNSN03--grf-----		

Habitat variables:

VBAW001 : Basal area of trees (if cut at 1.4m high) (m²/ha)
VDNSN03 : Density of snags that have >15cm DBH (#/ha)

GRAPH FUNCTION at level 2, position 1

Title: BASAL AREA (M2 / HA)

X:	0.000,	Y:	0.000
X:	10.000,	Y:	1.000
X:	20.000,	Y:	1.000
X:	30.000,	Y:	0.500
X:	40.000,	Y:	0.500

GRAPH FUNCTION at level 2, position 2

Title: # SNAGS > 15 CM DBH / HA

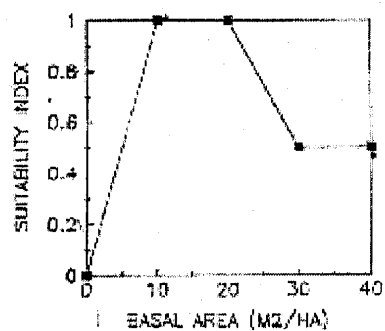
X:	0.000,	Y:	0.000
X:	12.500,	Y:	1.000
X:	15.000,	Y:	1.000

Comments:

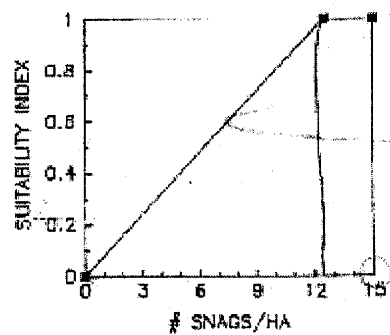
Density of snags rescaled to /ha.

$$\frac{1}{10} = \frac{x}{5}$$

DOWNY WOODPECKER VBAW001



DOWNY WOODPECKER VDNSN03



$$\frac{x}{12.5}$$

$$\frac{x}{0} = \frac{1}{12.5}$$

$$\frac{1.0}{12.5} = \frac{1.0}{12.5}$$

Library: B:LSNAKE.HLB
3-10-1990

Model # 1
Model name: SONG SPARROW

Single covertime model.

Verification level: Applied
Creation/modification date: 10-18-1989

USFWS. 1979. SONG SPARROW HSI MODEL. RCREGION 2410.

Covertypes:

PFO : Palustrine forested wetland
MS : MESIC SHRUB

Lev 4	Lev 3	Lev 2	Lev 1
	SDIPW01	grf	min--HSI
	VCVSH01	grf	gam
	VHTSH01	grf	

Habitat variables:

SDIPW01 : Mean distance to potable water (km, n)
VCVSH01 : Percent canopy cover of shrubs (i.e., all woody plants <6m tall) (%)
VHTSH01 : Mean height of shrubs (i.e., woody plants < 6m tall) (%)

GRAPH FUNCTION at level 3, position 2

Title: PERCENT SHRUB CROWN COVER (%)

X:	0.000,	Y:	0.000
X:	37.000,	Y:	1.000
X:	80.000,	Y:	1.000
X:	100.000,	Y:	0.500

GRAPH FUNCTION at level 3, position 3

Title: MEAN HEIGHT OF OVERSTORY SHRUBS (m)

X:	0.000,	Y:	0.000
X:	1.500,	Y:	1.000
X:	3.500,	Y:	1.000
X:	5.000,	Y:	0.500

GRAPH FUNCTION at level 2, position 1

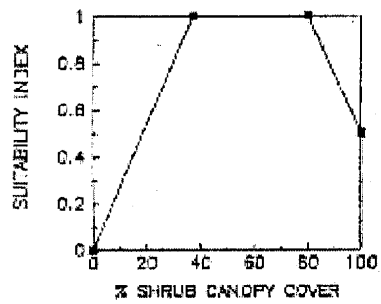
Title: DISTANCE TO WATER (m)

X:	0.000,	Y:	1.000
X:	200.000,	Y:	1.000
X:	400.000,	Y:	1.000
X:	600.000,	Y:	0.100
X:	800.000,	Y:	0.000

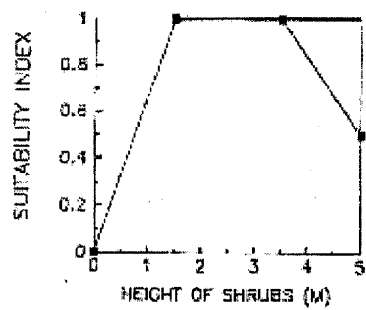
Comments:

<none>

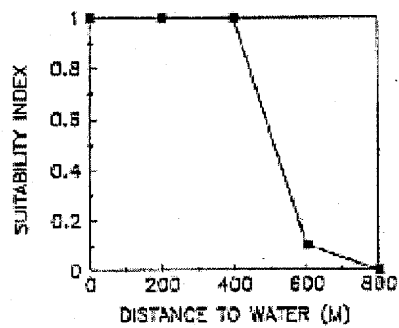
SONG SPARROW VCVSH01



SONG SPARROW VHTSH01



SONG SPARROW SDIPW01



Library: D:\LSNAKE.HLM
3-10-1990

Multi-covertime model.

Model name: CALIFORNIA QUAIL

Verification level: None

Creation/modification date: 10-13-1989

DEVELOPED FOR LOWER SNAKE RIVER APPLICATION.

Covertypes:

AC : Cropland
G : GRASS
UF : Forbland
MS : MESIC SHRUB
SS : SHRUBSTEPPE
PSS : Palustrine scrub/shrub wetland
PFO : Palustrine forested wetland

LIFE REQUISITE: FOOD

Covertypes:

AC

Lev 3 Lev 2 Lev 1
DISTESC--grf-----min-LRSI
DISTNST--grf-----

Habitat variables:

DISTESC : DISTANCE TO ESCAPE COVER (M)
DISTNST : DISTANCE TO ROOST COVER (M)

GRAPH FUNCTION at level 2, position 1

Title: DISTANCE TO ESCAPE COVER (M)

X:	0.000,	Y:	1.000
X:	50.000,	Y:	1.000
X:	150.000,	Y:	0.000
X:	1000.000,	Y:	0.000

GRAPH FUNCTION at level 2, position 2

Title: DISTANCE TO C. QUAIL ROOST COVER

X:	0.000,	Y:	1.000
X:	320.000,	Y:	1.000
X:	480.000,	Y:	0.000
X:	1000.000,	Y:	0.000

Comments:

1. CROP TYPES ASSUMED TO PROVIDE OPTIMAL FOOD.

LIFE REQUISITE: FOOD

Covertypes:

G, UF, MS, SS, PSS, PFO

Lev 3	Lev 2	Lev 1
VCVHRO1	--grf-----	usf-LRST
DISTRST	--grf-----	!
DISTESC	--grf-----	^

Habitat variables:

DISTESC : DISTANCE TO ESCAPE COVER (M)

DISTRST : DISTANCE TO ROOST COVER (M)

VCVHEU1 : Percent canopy cover of herba (non-woody plants: grasses & forbs) (%)

GRAPH FUNCTION at level 2, position 1

Title: % HERBACEOUS CANOPY COVER (%)

X:	0.000,	Y:	0.000
X:	25.000,	Y:	1.000
X:	75.000,	Y:	1.000
X:	100.000,	Y:	0.200

GRAPH FUNCTION at level 2, position 2

Title: DISTANCE TO C. QUAIL ROOST COVER (M)

X:	0.000,	Y:	1.000
X:	320.000,	Y:	1.000
X:	480.000,	Y:	0.000
X:	1000.000,	Y:	0.000

GRAPH FUNCTION at level 2, position 3

Title: DISTANCE TO C. QUAIL ESCAPE CVR (M)

X:	0.000,	Y:	1.000
X:	50.000,	Y:	1.000
X:	150.000,	Y:	0.000
X:	1000.000,	Y:	0.000

USER-SPECIFIED FUNCTION at level 1, position 1

USUB = X(1)*0.70

IF X(2) < X(3) THEN USUB = USUB*X(2)

IF X(3) <= X(2) THEN USUB = USUB*X(3)

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840.

lev 5 Lev 4 Lev 3 Lev 2 Lev 1

Habitat variables:

```

DISTPRST : DISTANCE TO HOOST COVER (M)
VCHVHER01 : Percent canopy cover of herbs (non-woody plants: grasses & forbs) (%)
VCHVSH01 : Percent canopy cover of shrubs (i.e., all woody plants <6m tall) (%)
VHTHER01 : Mean height of herbaceous canopy (not of individual plants) (cm)
VHTSH01 : Mean height of shrubs (i.e., woody plants < 6m tall) (%)

```

```

GRAPH FUNCTION at level 4, position 1
Title: % HERB CANOPY COVER (ESC CVR)
X:      0.000,   Y:   0.000
X:      50.000,   Y:   1.000
X:     100.000,   Y:   1.000

```

```

GRAPH FUNCTION at level 4, position 2
Title:  AVG. HT HERE VEGETATION (ESC CVR) (CM)
X:      0.000,  Y:  0.000
X:     30.000,  Y:  0.000
X:     61.000,  Y:  1.000
X:    200.000,  Y:  1.000

```

```

GRAPH FUNCTION at level 4, position 3
Title: % SHRUB CANOPY COVER
X:      0.000,  Y:  0.000
X:      20.000, Y:  1.000
X:     100.000, Y:  1.000

```

GRAPH FUNCTION at level 4, position 4
Title: AVG SHRUB HT (M)
X: 0.000, Y: 0.000
X: 1.000, Y: 1.000

X: 5.000, Y: 1.000

GRAPH FUNCTION at level 2, position 2

Title: DISTANCE TO C. QUAIL ROOST CVR (M)

X: 0.000, Y: 1.000
X: 320.000, Y: 1.000
X: 480.000, Y: 0.000
X: 1000.000, Y: 0.000

Comments:
<none>

LIFE REQUISITE: WTR RST

Covertypes:

MS, PSS, PFO, SS

Lev 4 Lev 3 Lev 2 Lev 1
VCVSH01--grf-----gem-----prd-LRSH
VHTSH01--g-rf-----
 DISTESC--grf-----

Vitat variables.

DESC : DISTANCE TO ESCAPE COVER (M)

VCVSH01 : Percent canopy cover of shrubs (i.e., all woody plants <6m tall) (%)

VHTSH01 : Mean height of shrubs (i.e., woody plants < 6m tall) (%)

GRAPH FUNCTION at level 3, position 1

Title: % SHRUB CANOPY COVER

X: 0.000, Y: 0.000
X: 20.000, Y: 1.000
X: 100.000, Y: 1.000

GRAPH FUNCTION at level 3, position 2

Title: AVG SHRUB HT (M)

X: 0.000, Y: 0.000
X: 1.000, Y: 0.200
X: 1.500, Y: 1.000
X: 5.000, Y: 1.000

GRAPH FUNCTION at level 2, position 2

Title: DISTANCE TO C. QUAIL ESCAPE CVR (M)

X: 0.000, Y: 1.000
X: 50.000, Y: 1.000

X: 150.000, Y: 0.000
X: 1000.000, Y: 0.000

Comments:
<none>

DISTANCE FUNCTION:

Title:
< not used >

HSI TREE DIAGRAM:

```
      Lev 3      Lev 2      Lev 1
FOOD-----grf-----min--HSI
ESC CVR--grf-----:
RST CVR--grf-----^
```

GRAPH FUNCTION at level 2, position 1

Title: EQUIVALENT OPTIMAL AREA (FOOD)

X: 0.000, Y: 0.000
X: 40.000, Y: 1.000
X: 100.000, Y: 1.000

GRAPH FUNCTION at level 2, position 2

Title: EQUIVALENT OPTIMAL AREA (ESC CVR)

X: 0.000, Y: 0.000
X: 25.000, Y: 1.000
X: 100.000, Y: 1.000

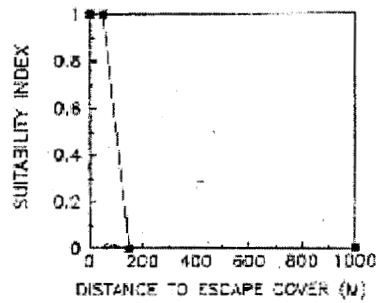
GRAPH FUNCTION at level 2, position 3

Title: EQUIVALENT OPTIMAL AREA (RST CVR)

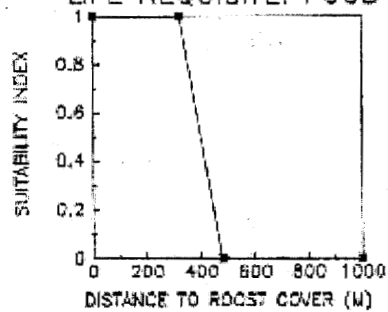
X: 0.000, Y: 0.000
X: 10.000, Y: 1.000
X: 100.000, Y: 1.000

Comments:
<none>

CALIFORNIA QUAIL DISTESC
LIFE REQUISITE: FOOD

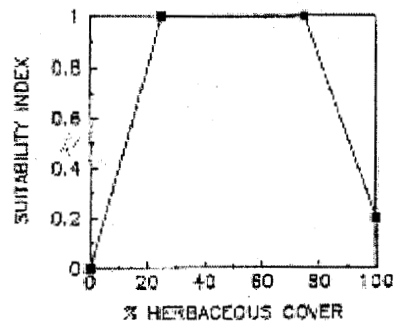


CALIFORNIA QUAIL DISTRST
LIFE REQUISITE: FOOD



500
1.500
3/1500

CALIFORNIA QUAIL VCVHE01 ✓
LIFE REQUISITE: FOOD



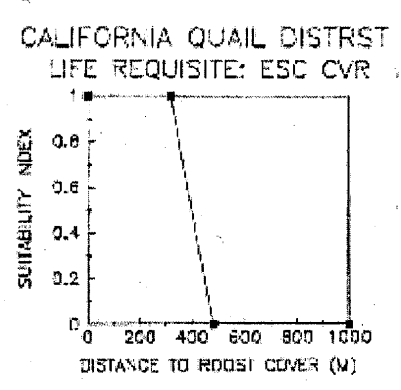
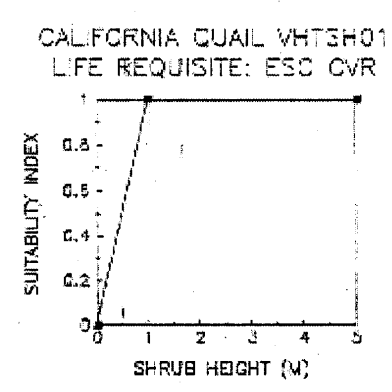
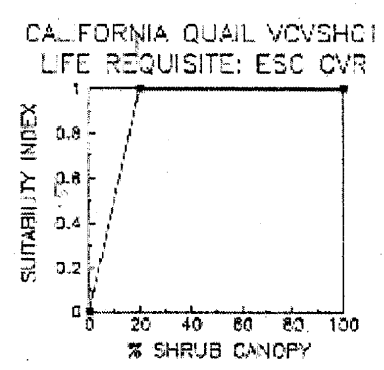
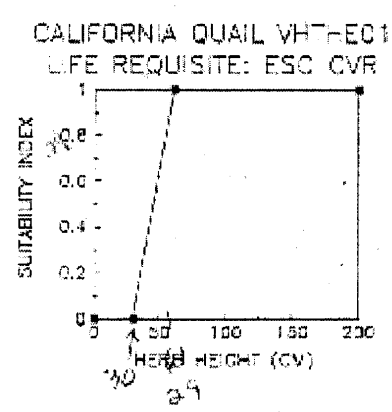
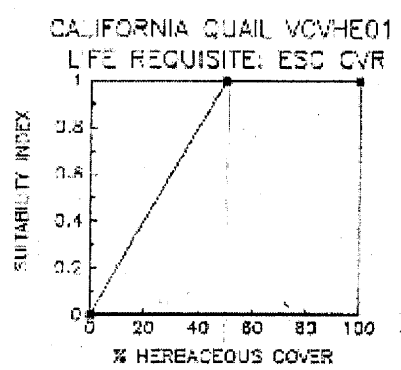
1/25 = 1/10

$$\frac{7}{8} = .875$$

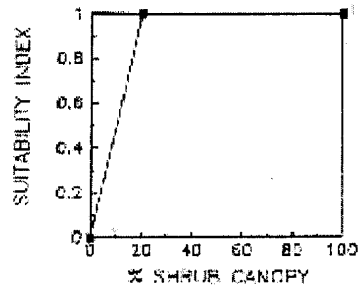
$$\frac{7}{15} = .46$$

$$\frac{1}{29} = \frac{1}{15}$$

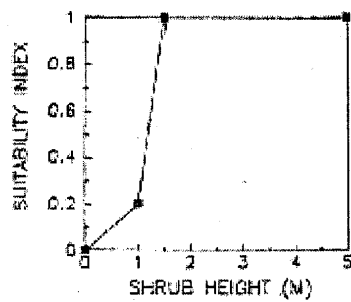
$$\frac{7}{15} = .46$$



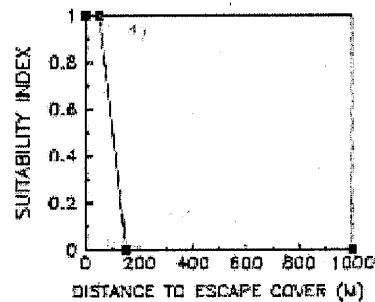
16-11
CALIFORNIA QUAIL VCVSH01
LIFE REQUISITE: WTR RST



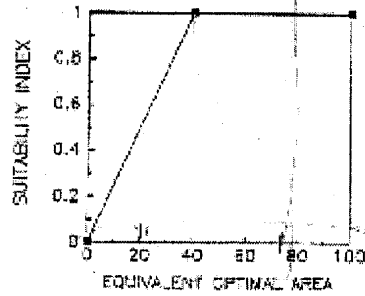
CALIFORNIA QUAIL VHTSH01
LIFE REQUISITE: WTR RST



CALIFORNIA QUAIL DISTESC
LIFE REQUISITE: WTR RST

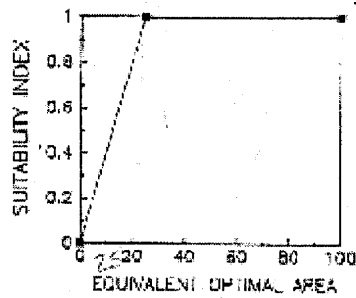


CALIFORNIA QUAIL EOA
LIFE REQUISITE: FOOD

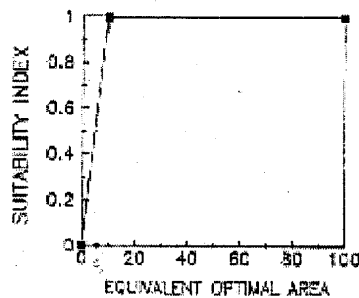


LR 81

CALIFORNIA QUAIL EOA
LIFE REQUISITE: ESC CVR



CALIFORNIA QUAIL EOA
LIFE REQUISITE: RST CVR



Library: D:LSNAKE.HLB
3-10-1990

Multi-covertypes model.

+1 name: RING-NECKED PHEASANT

Verification level: Applied

Creation/modification date: 12-4-1989

SCS. 1988. NORTH WHITSTAN PHEASANT (MOD.). SCS, WA. (IVAN LINES).

Covertypes:

UF : Forbland
MS : MESIC SHRUB
PFO : Palustrine forested wetland
PSS : Palustrine scrub/shrub wetland
SS : SHRUBSTEPPE
AC : Cropland
P : PASTURE
PEM : Palustrine emergent wetland

LIFE REQUISITE: REPRO

Covertypes:

UF, MS, PFO, PSS, SS

Lev 3 Lev 2 Lev 1
VCVHE01--g1f-----gem-LRS1
VHTHE01--grf-----"

Habitat variables:

VCVHE01 : Percent canopy cover of herbs (non-woody plants: grasses & forbs) (%)
VHTHE01 : Mean height of herbaceous canopy (not of individual plants) (cm)

GRAPH FUNCTION at level 2, position 1

Title: % HERBACEOUS CANOPY COVER

| | | | |
|----|----------|----|-------|
| X: | 0.000, | Y: | 0.000 |
| X: | 40.000, | Y: | 0.200 |
| X: | 50.000, | Y: | 1.000 |
| X: | 90.000, | Y: | 1.000 |
| X: | 100.000, | Y: | 0.400 |

VCVHE01

GRAPH FUNCTION at level 2, position 2

Title: HERBACEOUS VEGETATION HEIGHT (CM)

| | | | |
|----|---------|----|-------|
| X: | 0.000, | Y: | 0.000 |
| X: | 10.000, | Y: | 0.000 |
| X: | 60.000, | Y: | 1.000 |
| X: | 80.000, | Y: | 1.000 |

VHTHE01

X: 100.000, Y: 0.000

Comments:
<none>

LIFE REQUISITE: WTRCVR

Covertypes:

UF, MS, PFO, PSS, SS, PEM

Lev 3 Lev 2 Lev 1
CANPWIN--grf-----prd-LRSI
DSTWFOD--grf-----^

Habitat variables:

CANPWIN : PERCENT CANOPY COVER OF PERSISTENT WINTER COVER >0.5 M
DSTWFOD : DISTANCE TO WINTER FOOD (M) FOR PHEASANT

GRAPH FUNCTION at level 2, position 1

Title: % CANOPY OF PERSISTENT WINTER COVER >0.5 M

| | | | |
|----|----------|----|-------|
| X: | 0.000, | Y: | 0.000 |
| X: | 30.000, | Y: | 1.000 |
| X: | 60.000, | Y: | 1.000 |
| X: | 100.000, | Y: | 0.000 |

CANPWIN

GRAPH FUNCTION at level 2, position 2

Title: DIST. (M) TO PREF. WTR. FOOD (MS,AC,UF)

| | | | |
|----|----------|----|-------|
| X: | 0.000, | Y: | 1.000 |
| X: | 200.000, | Y: | 1.000 |
| X: | 400.000, | Y: | 0.800 |
| X: | 800.000, | Y: | 0.000 |

DSTWFOD

Comments:

PREFERRED WINTER FOOD IS PROVIDED BY MESIC SHRUB (MS), CROP (AC),
AND FORB (UF) COVER TYPES MEASURED FROM UF, MS, PFO, PSS, SS & PEM.

LIFE REQUISITE: WTRFOOD

Covertypes:

UF, MS, PFO, PSS, SS, G, AC

Lev 2 Lev 1
FOODCT---mnu-LRSI

Habitat variables:

FOODCT : PHEASANT WINTER FOOD TYPE (AC=1,UF=2,MS=3,PFO=4,PSS=5,SS=6,D=7)

FUNCTION at level 1, position 1

| | | | |
|--------------|---|---------------|-------|
| Menu choice: | 1 | Output value: | 1.000 |
| Menu choice: | 2 | Output value: | 0.700 |
| Menu choice: | 3 | Output value: | 0.500 |
| Menu choice: | 4 | Output value: | 0.400 |
| Menu choice: | 5 | Output value: | 0.300 |
| Menu choice: | 6 | Output value: | 0.300 |
| Menu choice: | 7 | Output value: | 0.300 |

FOODCT

Comments:

<none>

LIFE REQUISITE: REPRO

Covertypes:

AC, F

Lev 2 Lev 1
MOWJUN menu LRSI

Habitat variables:

JUN : CROPLAND PLOWED OR MOWED BEFORE JUNE 15 (LOWER SNARE PHEASANT)

MENU FUNCTION at level 1, position 1

| | | | |
|--------------|---|---------------|-------|
| Menu choice: | 1 | Output value: | 1.000 |
| Menu choice: | 2 | Output value: | 0.300 |
| Menu choice: | 3 | Output value: | 0.000 |

Comments:

MENU CHOICES FOR MOWJUN:

1 = COVER TYPE NOT MOWED DURING NESTING SEASON (E.G., HMO PASTURES).

2 = COVER TYPE MOWED OR PLOWED BEFORE JUNE 15 (E.G., CROPS).

3 = COVER TYPE MOWED OFTEN DURING NESTING SEASON (E.G., GOOSE PASTURES).

DISTANCE FUNCTION:

Title:

< not used >

HSI TREE DIAGRAM:

Lev 3 Lev 2 Lev 1
REPRO----grf-----min--HSI

WTRCVH---grf-----:
WTRFOOD---grf-----^

GRAPH FUNCTION at level 2, position 1

Title: EQUIVALENT OPTIMAL AREA FOR REPRODUCTION

| | | | |
|----|----------|----|-------|
| X: | 0.000, | Y: | 0.000 |
| X: | 50.000, | Y: | 1.000 |
| X: | 100.000, | Y: | 1.000 |

GRAPH FUNCTION at level 2, position 2

Title: EQUIVALENT OPTIMAL AREA OF WINTER COVER

| | | | |
|----|----------|----|-------|
| X: | 0.000, | Y: | 0.000 |
| X: | 30.000, | Y: | 1.000 |
| X: | 100.000, | Y: | 1.000 |

GRAPH FUNCTION at level 2, position 3

Title: EQUIVALENT OPTIMAL AREA OF WINTER FOOD

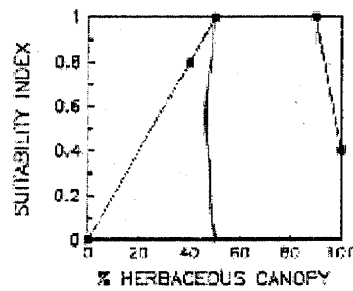
| | | | |
|----|----------|----|-------|
| X: | 0.000, | Y: | 0.000 |
| X: | 50.000, | Y: | 1.000 |
| X: | 100.000, | Y: | 1.000 |

Comments:

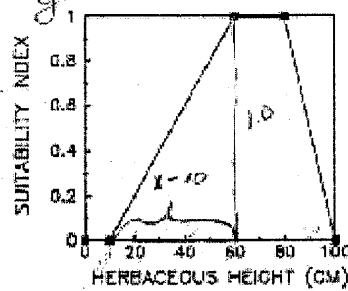
<none>

$\frac{1}{50} = \frac{x}{23}$
 $\frac{1}{50} = \frac{4}{10}$
 $\frac{1}{50} = \frac{20}{100}$

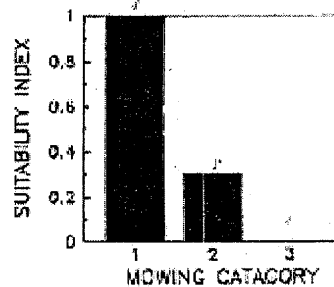
PHEASANT VCVHE01
LIFE REQUISITE: REPRO



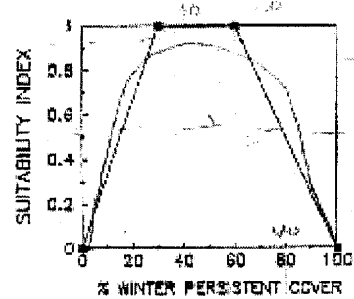
PHEASANT VHTHE01
LIFE REQUISITE: REPRO



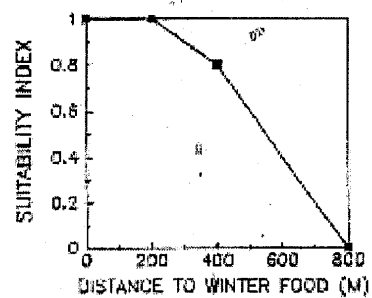
PHEASANT MOWJUN
LIFE REQUISITE: REPRO



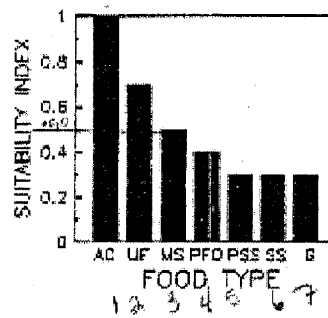
PHEASANT CANPWIN
LIFE REQUISITE: WTRCVR



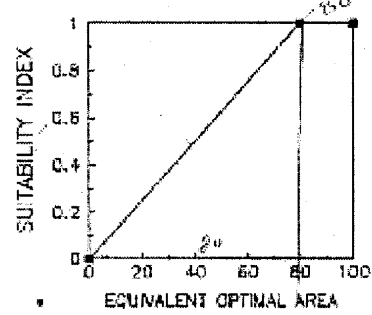
PHEASANT DSTWFOD
LIFE REQUISITE: WTRCVR



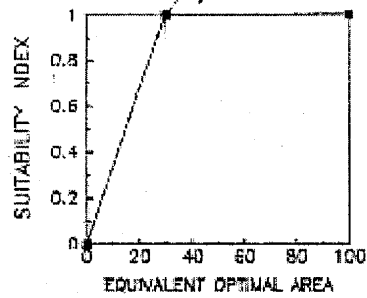
PHEASANT FOODCT
LIFE REQUISITE: WTRFOOD



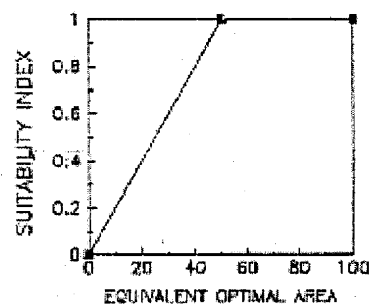
PHEASANT EOA
LIFE REQUISITE: REPRO



PHEASANT EOA
LIFE REQUISITE: WTRCVR



PHEASANT EOA
LIFE REQUISITE: WTRFOD



Library: D:\LSNAKE.HLB
3-23-1990

Single covertype model.

Model name: CANADA GOOSE

Verification level: Applied

Creation/modification date: 1-5-1990

USFWS. 1985. WILDLIFE IMPACT ASSESSMENT, PALISADES PROJECT,
CANADA GOOSE HSI MODEL. (MODIFIED FOR LOWER SNAKE RIVER PROJECT)

Covertypes:

SHOR100 : HABITAT BAND 100M WIDE X LENGTH OF RES. + ISLANDS, ALL COVER TYPES INC

| Lev 3 | Lev 2 | Lev 1 |
|------------|----------|----------|
| ISL1----- | grf----- | min--HSI |
| BRHAB----- | grf----- | ^ |

Habitat variables:

BRHAB : BROOD-BEARING HABITAT

ISL1 : NESTING ISLAND SUITABILITY

GRAPH FUNCTION at level 2, position 1

Title: ISL1

| | | | |
|----|--------|----|-------|
| X: | 0.000, | Y: | 0.000 |
| X: | 0.300, | Y: | 0.300 |
| X: | 0.600, | Y: | 0.600 |
| X: | 1.000, | Y: | 1.000 |

GRAPH FUNCTION at level 2, position 2

Title: BRHAB

| | | | |
|----|--------|----|-------|
| X: | 0.000, | Y: | 0.000 |
| X: | 0.500, | Y: | 0.500 |
| X: | 1.000, | Y: | 1.000 |

Comments:

CODES WERE CONVERTED TO SI, SI WERE THEN USED TO CALCULATE MEANS.

GRAPH FUNCTIONS ARE A RESULT OF CONVERTING CODES TO SI FOR INPUT

ISL1 - NESTING ISLAND SUITABILITY:

1 = AT LEAST ONE ISLAND PRESENT WITH RELATIVELY HIGH SHORELINE/AREA
RATIO AND MODERATE VEGETATIVE CANOPY COVER, SI = 1.0.

2 = AT LEAST ONE ISLAND PRESENT WITH RELATIVELY LOW SHORELINE/AREA
RATIO AND/OR HIGH OR MINIMAL VEGETATIVE CANOPY COVER, SI = 0.6.

3 = AT LEAST ONE ISLAND PRESENT WITH NO VEGETATION OR AT LEAST ONE
NESTING TUB PRESENT, SI = 0.3.

4 = NO ISLAND OR NESTING TUB PRESENT, SI = 0.0.

BRHAB - BROOD REARING HABITAT:

1 = MINIMUM 1 ACRE OF ACCESSIBLE PASTURE AND LITTLE OR NO SHORELINE

COVER PRESENT AND MINIMAL TO NO COVER SURROUNDING PASTURE AND SUITABLE

HERBACEOUS FORAGE PRESENT, SI = 1.0.

2 = MINIMUM 1 ACRE OF ACCESSIBLE PASTURE AND MODERATE SHORELINE COVER
SENT AND/OR MODERATE COVER SURROUNDING PASTURE OR SUITABLE

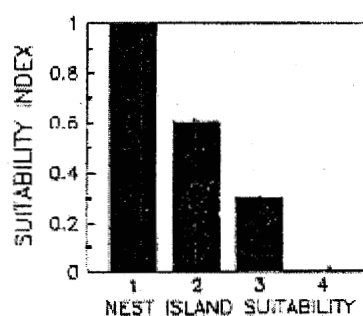
HERBACEOUS FORAGE PRESENT FOR ONLY PART OF BROODING PERIOD (LATE
APRIL-JULY), SI = 0.5.

3 = ACCESS TO PASTURE PRECLUDED BY CUTBANK, CLIFF, RIP-RAP, OR

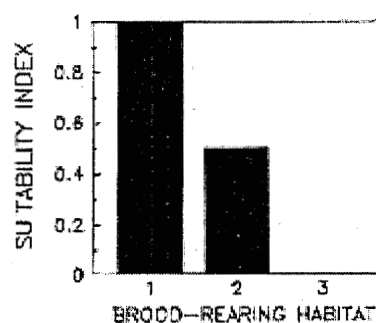
BROAD MUD OR SAND BARS ON LESS THAN 1 ACRE IN SIZE OR DENSE

VEGETATIVE COVER SURROUNDING PASTURE OR FORAGE NOT SUITABLE, SI = 0

CANADA GOOSE ISL1



CANADA GOOSE BRHAB



Canada Goose Model

From
Wildlife Impact Assessment
John Day Project, Oregon and Washington (see Page 36)

Rasmussen and Wright 1991

This model is a modification of the Canada goose model developed by Dave Lockman et al. for the evaluation of Canada goose nesting and brooding habitat on the Snake River at Palisades Reservoir. This modification was developed by Patrick Wright, Larry Rasmussen, and Jim Bottorff of the Portland Field Station, Fish and Wildlife Service and The Dalles, John Day, and McNary wildlife loss assessment HEP team members for use in describing the quality of nesting and brooding habitats in the vicinity of these projects.

Nesting Habitat

| <u>Islands (V1)</u> | <u>SI Value</u> |
|--|-----------------|
| Stable islands present; islands have relative high shoreline/area ratio; cover indicative of stability; ground cover on portions of island 4" - 8" high. | 0.8-1.0 |
| Stable islands present; relatively low shoreline/area ratio; cover on island <4" or >8". | 0.5-0.7 |
| No stable islands, or islands with limited or no cover. | 0.0-0.4 |

Brood Rearing Habitat

Late April – July

| <u>Foraging Area (V3)</u> | <u>SI Value</u> |
|--|-----------------|
| Distance from nesting areas to foraging zones ≤ 1 mile (preferable within site of the nesting area); forage ≤ 4 " tall and \geq one acre in size; foraging zones total ≥ 10 acres per mile of river; access to foraging zone within 25 meters of open water and not precluded by physical obstruction or dense vegetation (predator cover). | 0.7-1.0 |
| Distance from nesting areas to foraging zones ≥ 1 and ≤ 2 miles; forage ≤ 4 " tall and \geq one acre in size, foraging zones total 5 to 10 acres per mile of river; > 25 meters but < 50 meters from open water (escape cover). | 0.4 – 0.6 |
| As above except foraging zone > 2 miles from nesting areas and > 50 meters from open water (escape cover). | 0.0-0.3 |

Model Equation

$$HSI = \frac{V1 + V3}{2}$$

APPENDIX B

Baseline HEP Data Analysis

Wallender Property - Ring-necked Pheasant

REPRO (Rip S/S)

V1 - % herb cover SI = 0.7
RSS1 100 % SI = 0.4
RSS2 88 % SI = 1.0
V2 - ave. ht of herbs SI = 0.98
RSS1 81.9 cm SI = 0.96
RSS2 65.6 cm SI = 1.0

$$\text{LRSI} = (\text{V1} \times \text{V2})^{1/2}$$
$$\text{LRSI} = 0.83$$

REPRO (Agland)

V3 - plowing/mowing frequency 1/4 area is 0.25. 3/4 area is 1.0 SI = 0.25

$$\text{LRSI} = \text{V3}$$
$$\text{LRSI} = 0.25$$

WINTER COVER (Rip S/S)

V1 - % cover of persist. veg. SI = 0.61
RSS1 6.9 % SI = 0.22
RSS2 47.3 % SI = 1.0
V2 - dist to winter food (agland) 43 ft (14.3 m) SI = 1.0

$$\text{LRSI} = \text{V1} \times \text{V2}$$
$$\text{LRSI} = 0.61$$

WINTER FOOD (Rip S/S)

V1 - Food Type SI = 0.3

$$\text{LRSI} = \text{V1}$$
$$\text{LRSI} = 0.3$$

WINTER FOOD (Agland)

V1 - Food Type SI = 1.0

$$\text{LRSI} = \text{V1}$$
$$\text{LRSI} = 1.0$$

Relative Habitat Area calculations

Total project area: 309.66 acres

Agland: 295.49 acres

Rip S/S: 14.17 acres

Relative area of Rip S/S: 14.17 divided by 309.66 = 0.046

Relative area of Agland: 295.49 divided by 309.66 = 0.95

Equivalent Optimum Area calculations (relative area x LRSI) x 100

Agland

REPRO: $(0.95 \times 0.25) \times 100 = 23.75$

WINTER COVER: $(0.95 \times \text{NA}) \times 100 = 0$

WINTER FOOD: $(0.95 \times 1.0) \times 100 = 95$

Rip S/S

REPRO: $(0.046 \times 0.83) \times 100 = 3.82$

WINTER COVER: $(0.046 \times 0.61) \times 100 = 2.81$

WINTER FOOD: $(0.046 \times 0.3) \times 100 = 1.38$

| | REPRO | WINTER COVER | WINTER FOOD |
|----------------|-------|--------------|-------------|
| <u>Agland</u> | 23.75 | 0 | 95 |
| <u>Rip S/S</u> | 3.82 | 2.81 | 1.38 |
| Total: | 27.57 | 2.81 | 96.38 |
| EOA SI: | 0.345 | 0.094 | 1.0 |

HSI = min of LR EOAs

HSI = 0.094

HUs = HSI x Acres of suitable habitat

HUs = 0.094 x 309.66

HUs = 29.11

Note: the EOA SIs are based on the SI graphs for the LRs

Wallender Property - California Quail

FOOD1 (Agland)

| | | |
|-------------------------------|------------------|--------|
| V1 – Distance to escape cover | 1,632 ft (544 m) | SI = 0 |
| V2 – Distance to roost cover | 1,632 ft (544 m) | SI = 0 |

LRSI = Min of V1 or V2
LRSI = 0

FOOD2 (Rip S/S)

| | | |
|---------------------------|-----------|-----------|
| V3 – Dist to escape cover | 0 m | SI = 1.0 |
| V2 – Dist to roost cover | 0 m | SI = 1.0 |
| V1 - % cover of herbs | | SI = 0.38 |
| RSS1 100 % | SI = 0.2 | |
| RSS2 88 % | SI = 0.51 | |

LRSI = (V1 x 0.75) x min of V2 or V3
LRSI = 0.29

ESCAPE (Rip S/S)

| | | |
|----------------------------------|----------|----------|
| V5 – Dist to roost cover | 0 m | SI = 1.0 |
| V1 - % cover of herbs | | SI = 1.0 |
| RSS1 100% | SI = 1.0 | |
| RSS2 88% | SI = 1.0 | |
| V3 - % shrub cover (live & dead) | | SI = 1.0 |
| RSS1 76/300 ft = 25 % | SI = 1.0 | |
| RSS2 113/300 ft = 38 % | SI = 1.0 | |
| V2 – ave. ht. of herbs | | SI = 1.0 |
| RSS1 81.9 cm | SI = 1.0 | |
| RSS2 65.6 cm | SI = 1.0 | |
| V4 – ave. ht of shrubs | | SI = 1.0 |
| RSS1 43.2/44 = 0.98 m | SI = 1.0 | |
| RSS2 117.8/35 = 3.37 m | SI = 1.0 | |

LRSI = V5 x max of (V1 x V2)^{1/2} or (V3 x V4)^{1/2}
LRSI = 1.0

WINTER ROOST (Rip S/S)

| | | |
|---------------------------|----------|----------|
| V3 – dist to escape cover | 0 m | SI = 1.0 |
| V1 - % shrub cover | | SI = 1.0 |
| RSS1 25 % | SI = 1.0 | |
| Rss2 38 % | SI = 1.0 | |

V2 – ave. shrub ht. (live & dead)

RSS1 0.98 m

RSS2 3.37 m

SI = 0.2

SI = 1.0

SI = 0.6

$LRSI = (V1 \times V2)^{1/2} \times V3$

LRSI = 0.78

Relative Habitat Area calculations

Total project area: 309.66 acres; Suitable Habitat area: 309.66 acres

Agland: 295.49 acres

Rip S/S: 14.17 acres

Relative area of Rip S/S: 14.17 divided by 309.66 = 0.046

Relative area of Agland: 295.49 divided by 309.66 = 0.95

Equivalent Optimum Area calculations (relative area x LRSI) x 100

Agland

FOOD1: $(0.95 \times 0) \times 100 = 0$

ESCAPE COVER: $(0.95 \times \text{NA}) \times 100 = 0$

WINTER ROOST: $(0.95 \times \text{NA}) \times 100 = 0$

Rip S/S

FOOD2: $(0.046 \times 0.29) \times 100 = 1.33$

ESCAPE COVER: $(0.046 \times 1.0) \times 100 = 4.6$

WINTER ROOST: $(0.046 \times 0.78) \times 100 = 3.59$

| | FOOD | ESCAPE COVER | WINTER ROOST |
|----------------|-------------|---------------------|---------------------|
| <u>Agland</u> | 0 | 0 | 0 |
| <u>Rip S/S</u> | 1.33 | 4.6 | 3.59 |
| Total: | 1.33 | 4.6 | 3.59 |
| EOA SI: | 0.033 | 0.23 | 0.359 |

HSI = min of LR EOAs

HSI = 0.033

HUs = HSI x Acres of suitable habitat

HUs = 0.033 x 309.66

HUs = 10.22

Note: the EOA SIs are based on the SI graphs for the LRs

Wallender Property - Yellow Warbler

RSS1

| | | |
|---------------------------|-------------------|----------|
| V1 - % shrub cover (live) | 63/300 ft = 21 % | SI = 0.3 |
| V2 - ave. ht. of shrubs | 36.55/36 = 1.02 m | SI = 0.5 |
| V3 - % hydrophytic shrubs | <1 % | SI = 0.1 |

$$HSI = (V1 \times V2 \times V3)^{1/2}$$

$$HSI = (0.3 \times 0.5 \times 0.1)^{1/2}$$

$$HSI = (0.015)^{1/2}$$

$$HSI = 0.12$$

RSS2

| | | |
|---------------------------|------------------|-----------|
| V1 - % shrub cover (live) | 84/300 ft = 28 % | SI = 0.45 |
| V2 - ave. ht. of shrubs | 80.6/22 = 2.66 m | SI = 1.0 |
| V3 - % hydrophytic shrubs | 100% | SI = 1.0 |

$$HSI = (V1 \times V2 \times V3)^{1/2}$$

$$HSI = (0.45 \times 1.0 \times 1.0)^{1/2}$$

$$HSI = (0.45)^{1/2}$$

$$HSI = 0.67$$

Overall HSI = ave. HSI of RSS1 and RSS2

$$\text{Overall HSI} = 0.4$$

$$HUs = HSI \times 14.17 \text{ acres}$$

$$HUs = 0.4 \times 14.17$$

$$HUs = 5.68$$

Note: RSS1 = Rip S/S Transect #1 and RSS2 = Rip S/S Transect #2

Simonis Property - Ring-necked Pheasant

REPRO (Rip S/S)

| | | |
|------------------------|-----------|-----------|
| V1 - % herb cover | | SI = 0.52 |
| RSS1 100 % | SI = 0.4 | |
| RSS2 96 % | SI = 0.64 | |
| V2 - ave. ht of herbs | | SI = 0.73 |
| RSS1 688/12 = 57.33 cm | SI = 0.95 | |
| RSS2 461/13 = 35.46 cm | SI = 0.51 | |

$$\text{LRSI} = (\text{V1} \times \text{V2})^{1/2}$$
$$\text{LRSI} = 0.62$$

REPRO (Agland)

| | | |
|-------------------------------|--------------------------------|------------|
| V3 - plowing/mowing frequency | 31% is Level 2, 69% is Level 1 | SI = 0.783 |
|-------------------------------|--------------------------------|------------|

$$\text{LRSI} = \text{V3}$$
$$\text{LRSI} = 0.783$$

WINTER COVER (Rip S/S)

| | | |
|-----------------------------------|-------------|------------|
| V1 - % cover of persist. veg. | | SI = 0.023 |
| RSS1 0.58 % | SI = 0.019 | |
| RSS2 0.77 % | SI = 0.026 | |
| V2 - dist to winter food (agland) | 21 ft (7 m) | SI = 1.0 |

$$\text{LRSI} = \text{V1} \times \text{V2}$$
$$\text{LRSI} = 0.023$$

WINTER COVER (Emerg. Wet)

| | | |
|-----------------------------------|-----------------|----------|
| V1 - % cover of persist. veg. | 45.36 % | SI = 1.0 |
| V2 - dist to winter food (agland) | 101 ft (33.7 m) | SI = 1.0 |

$$\text{LRSI} = \text{V1} \times \text{V2}$$
$$\text{LRSI} = 1.0$$

WINTER FOOD (Rip S/S)

| | |
|----------------|----------|
| V1 - Food Type | SI = 0.3 |
|----------------|----------|

$$\text{LRSI} = \text{V1}$$
$$\text{LRSI} = 0.3$$

WINTER FOOD (Agland)

V1 - Food Type

SI = 1.0

LRSI = V1

LRSI = 1.0

Relative Habitat Area calculations

Total project area: 375.49 acres; Suitable Habitat area: 309.23 acres

Agland: 342.31 acres – 62.5 (city easement area) = 279.81 acres

Rip S/S: 7.82 acres

Emerg. Wet: 21.6 acres

Relative area of Agland: 279.81 divided by 309.23 = 0.905

Relative area of Rip S/S: 7.82 divided by 309.23 = 0.025

Relative area of Emer. Wet: 21.6 divided by 309.23 = 0.07

Equivalent Optimum Area calculations (relative area x LRSI) x 100

Agland

REPRO: $(0.905 \times 0.783) \times 100 = 70.86$

WINTER COVER: $(0.905 \times \text{NA}) \times 100 = 0$

WINTER FOOD: $(0.905 \times 1.0) \times 100 = 90.5$

Rip S/S

REPRO: $(0.025 \times 0.62) \times 100 = 1.55$

WINTER COVER: $(0.025 \times 0.023) \times 100 = 0.058$

WINTER FOOD: $(0.025 \times 0.3) \times 100 = 0.75$

Emerg. Wet.

REPRO: $(0.07 \times \text{NA}) \times 100 = 0$

WINTER COVER: $(0.07 \times 1.0) \times 100 = 7.0$

WINTER FOOD: $(0.07 \times \text{NA}) \times 100 = 0$

| | REPRO | | WINTER COVER | WINTER FOOD |
|-------------------|-------|-------|--------------|-------------|
| <u>Agland</u> | 70.86 | 0 | 90.5 | |
| <u>Rip S/S</u> | 1.55 | | 0.058 | 0.75 |
| <u>Emerg Wet.</u> | 0 | 7 | 0 | |
| Total: | 72.41 | 7.058 | 91.25 | |
| EOA SI: | 0.905 | | 0.235 | 1.0 |

HSI = min of LR EOAs

HSI = 0.235

HUs = HSI x Acres of suitable habitat

HUs = 0.235×309.23

HUs = 72.67

Note: the EOA SIs are based on the SI graphs for the LRs

Simonis Property - California Quail

FOOD1 (Agland)

| | | |
|-------------------------------|------------------|--------|
| V1 – Distance to escape cover | 1,178 ft (393 m) | SI = 0 |
| V2 – Distance to roost cover | 1,178 ft (393 m) | SI = 0 |

LRSI = Min of V1 or V2

LRSI = 0

FOOD2 (Rip S/S)

| | | |
|---------------------------|-----------|-----------|
| V3 – Dist to escape cover | 0 m | SI = 1.0 |
| V2 – Dist to roost cover | 0 m | SI = 1.0 |
| V1 - % cover of herbs | | SI = 0.28 |
| RSS1 100 % | SI = 0.2 | |
| RSS2 96 % | SI = 0.36 | |

LRSI = (V1 x 0.75) x min of V2 or V3

LRSI = 0.21 x min of 1.0 or 1.0

LRSI = 0.21

ESCAPE (Rip S/S)

| | | |
|----------------------------------|-----------|----------|
| V5 – Dist to roost cover | 0 m | SI = 1.0 |
| V1 - % cover of herbs | | SI = 1.0 |
| RSS1 100 % | SI = 1.0 | |
| RSS2 96 % | SI = 1.0 | |
| V3 - % shrub cover (live & dead) | | SI = 0.5 |
| RSS1 0/275 ft = 0 % | SI = 0 | |
| RSS2 258/300 ft = 86 % | SI = 1.0 | |
| V2 – ave. ht. of herbs | | SI = 0.5 |
| RSS1 688/12 = 57.33 cm | SI = 0.85 | |
| RSS2 461/13 = 35.46 cm | SI = 0.14 | |
| V4 – ave. ht of shrubs | | SI = 0.5 |
| RSS1 0 m | SI = 0 | |
| RSS2 64.8/21 = 3.09 m | SI = 1.0 | |

LRSI = V5 x max of (V1 x V2)^{1/2} or (V3 x V4)^{1/2}

LRSI = 1.0 x max of 0.71 or 0.5

LRSI = 1.0 x 0.71

LRSI = 0.71

WINTER ROOST (Rip S/S)

| | | |
|-----------------------------------|----------|----------|
| V3 – dist to escape cover | 0 m | SI = 1.0 |
| V1 - % shrub cover | | SI = 0.5 |
| RSS1 0 % | SI = 0 | |
| RSS2 86 % | SI = 1.0 | |
| V2 – ave. shrub ht. (live & dead) | | SI = 0.5 |
| RSS1 0 m | SI = 0 | |
| RSS2 3.09 m | SI = 1.0 | |

$$\text{LRSI} = (\text{V1} \times \text{V2})^{1/2} \times \text{V3}$$

$$\text{LRSI} = 0.5 \times 1.0$$

$$\text{LRSI} = 0.5$$

Relative Habitat Area calculations

Total project area: 375.49 acres; Suitable Habitat area: 287.63 acres

Agland: 342.31 acres – 62.5 acres (city easement area) = 279.81 acres

Rip S/S: 7.82 acres

Relative area of Agland: 279.81 divided by 287.63 = 0.973

Relative area of Rip S/S: 7.82 divided by 287.63 = 0.027

Equivalent Optimum Area calculations (relative area x LRSI) x 100**Agland**

$$\text{FOOD1: } (0.973 \times 0) \times 100 = 0$$

$$\text{ESCAPE COVER: } (0.973 \times \text{NA}) \times 100 = 0$$

$$\text{WINTER ROOST: } (0.973 \times \text{NA}) \times 100 = 0$$

Rip S/S

$$\text{FOOD2: } (0.027 \times 0.21) \times 100 = 0.567$$

$$\text{ESCAPE COVER: } (0.027 \times 0.71) \times 100 = 1.917$$

$$\text{WINTER ROOST: } (0.027 \times 0.5) \times 100 = 1.35$$

| | FOOD | ESCAPE COVER | WINTER ROOST |
|----------------|-------------|---------------------|---------------------|
| <u>Agland</u> | 0 | 0 | 0 |
| <u>Rip S/S</u> | 0.567 | 1.917 | 1.35 |
| Total: | 0.567 | 1.917 | 1.35 |
| EOA SI: | 0.014 | 0.077 | 0.135 |

HSI = min of LR EOAs

HSI = 0.014

HUs = HSI x Acres of suitable habitat

HUs = 0.014 x 287.63

HUs = 4.03

Note: the EOA SIs are based on the SI graphs for the LRs

Simonis Property - Yellow Warbler

RSS1

| | | |
|---------------------------|---------------|--------|
| V1 - % shrub cover (live) | 0/300 ft = 0% | SI = 0 |
| V2 - ave. ht. of shrubs | 0 m | SI = 0 |
| V3 - % hydrophytic shrubs | 0 % | SI = 0 |

$$HSI = (V1 \times V2 \times V3)^{1/2}$$

$$HSI = (0 \times 0 \times 0)^{1/2}$$

$$HSI = 0$$

RSS2

| | | |
|---------------------------|-------------------|-----------|
| V1 - % shrub cover (live) | 236/300 ft = 88 % | SI = 0.84 |
| V2 - ave. ht. of shrubs | 61.3/19 = 3.23 m | SI = 1.0 |
| V3 - % hydrophytic shrubs | 100 % | SI = 1.0 |

$$HSI = (V1 \times V2 \times V3)^{1/2}$$

$$HSI = (0.84 \times 1.0 \times 1.0)^{1/2}$$

$$HSI = (0.84)^{1/2}$$

$$HSI = 0.92$$

Overall HSI = ave. HSI of RSS1 and RSS2

$$\text{Overall HSI} = 0.46$$

$$HUs = HSI \times 7.82 \text{ acres}$$

$$HUs = 0.46 \times 7.82$$

$$HUs = 3.597$$

Note: RSS1 = Rip S/S Transect #1 and RSS2 = Rip S/S Transect #2

Conley Lake Property - Ring-necked Pheasant

REPRO (Agland)

V3 – plowing/mowing frequency entire area is Level 1 SI = 1.0

LRSI = V3

LRSI = 1.0

WINTER COVER (Emerg. Wet)

V1 - % cover of persist. veg. 11.54 % SI = 0.385

V2 - dist to winter food (agland) 433 ft (144 m) SI = 1.0

LRSI = V1 x V2

LRSI = 0.385

WINTER FOOD (Agland)

V1 - Food Type SI = 1.0

LRSI = V1

LRSI = 1.0

Relative Habitat Area calculations

Total project area: 161.07 acres; Suitable Habitat area: 161.07 acres

Agland: 61.99 acres

Emerg. Wet: 99.08 acres

Relative area of Agland: 61.99 divided by 161.07 = 0.385

Relative area of Emer. Wet: 99.08 divided by 161.07 = 0.615

Equivalent Optimum Area calculations (relative area x LRSI) x 100

Agland

REPRO: $(0.385 \times 1.0) \times 100 = 38.5$

WINTER COVER: $(0.385 \times \text{NA}) \times 100 = 0$

WINTER FOOD: $(0.385 \times 1.0) \times 100 = 38.5$

Emerg. Wet.

$$\text{REPRO: } (0.615 \times \text{NA}) \times 100 = 0$$

$$\text{WINTER COVER: } (0.615 \times 0.385) \times 100 = 23.678$$

$$\text{WINTER FOOD: } (0.615 \times \text{NA}) \times 100 = 0$$

| | REPRO | WINTER COVER | WINTER FOOD |
|-------------------|-------|--------------|-------------|
| <u>Agland</u> | 38.5 | 0 | 38.5 |
| <u>Emerg Wet.</u> | 0 | 23.678 | 0 |
| Total: | 38.5 | 23.678 | 38.5 |

EOA SI: 0.48

0.789

0.77

HSI = min of LR EOAs

$$\text{HSI} = 0.48$$

HUs = HSI x Acres of suitable habitat

$$\text{HUs} = 0.48 \times 161.07$$

$$\text{HUs} = 77.31$$

Note: the EOA SIs are based on the SI graphs for the LRs

Conley Lake - California Quail

FOOD1 (Agland)

V1 – Distance to escape cover 407 ft (136 m) SI = 0.154
V2 – Distance to roost cover 407 ft (136 m) SI = 1.0

LRSI = Min of V1 or V2
LRSI = 0.154

ESCAPE COVER
present)

SI = NA (No suitable cover types

WINTER ROOST
present)

SI = NA (no suitable cover types

Relative Habitat Area calculations

Total project area: 161.07 acres; Suitable Habitat area: 61.99 acres

Agland: 61.99 acres
Emerg., Wet. 99.08

Relative area of Agland: 61.99 divided by 161.07 = 0.385

Equivalent Optimum Area calculations (relative area x LRSI) x 100

Agland

FOOD1: (0.385 x 0.154) x 100 = 5.929
ESCAPE COVER: (0.385 x NA) x 100 = 0
WINTER ROOST: (0.385 x NA) x 100 = 0

| | FOOD | ESCAPE COVER | WINTER ROOST |
|---------------|-------------|---------------------|---------------------|
| <u>Agland</u> | 5.929 | 0 | 0 |
| Total: | 5.929 | 0 | 0 |
| EOA SI: | 0.148 | 0 | 0 |

HSI = min of LR EOAs

$$\text{HSI} = 0$$

$$\begin{aligned}\text{HUs} &= \text{HSI} \times \text{Acres of suitable habitat} \\ \text{HUs} &= 0 \times 61.99\end{aligned}$$

$$\text{HUs} = 0$$

Note: the EOA SIs are based on the SI graphs for the LRs

Becker Property - Ring-necked Pheasant

REPRO (Rip S/S)

| | | |
|-----------------------|-----------|-----------|
| V1 - % herb cover | | SI = 0.63 |
| RSS1 60 % | SI = 1.0 | |
| RSS2 13 % | SI = 0.26 | |
| V2 - ave. ht of herbs | | SI = 0.41 |
| RSS1 50.8 cm | SI = 0.82 | |
| RSS2 9.16 cm | SI = 0 | |

$$\text{LRSI} = (\text{V1} \times \text{V2})^{1/2}$$

$$\text{LRSI} = 0.51$$

REPRO (Agland)

| | |
|--|------------------------------|
| V3 - plowing/mowing frequency present) | SI = NA (Agland not present) |
|--|------------------------------|

WINTER COVER (Rip S/S)

| | | |
|-----------------------------------|----------------|-----------|
| V1 - % cover of persist. veg. | | SI = 0.71 |
| RSS1 12.5 % | SI = 0.42 | |
| RSS2 44.2 | SI = 1.0 | |
| V2 - dist to winter food (agland) | 701 ft (234 m) | SI = 0.96 |

$$\text{LRSI} = \text{V1} \times \text{V2}$$

$$\text{LRSI} = 0.68$$

WINTER COVER (Emerg. Wet.)

| | | |
|-----------------------------------|---------------|------------|
| V1 - % cover of persist. veg. | | SI = 0.015 |
| EW1 0 % | SI = 0 | |
| EW2 0.77 % | SI = 0.03 | |
| V2 - dist to winter food (agland) | 177 ft (59 m) | SI = 1.0 |

$$\text{LRSI} = \text{V1} \times \text{V2}$$

$$\text{LRSI} = 0.015$$

WINTER FOOD (Rip S/S)

| | |
|----------------|----------|
| V1 - Food Type | SI = 0.3 |
|----------------|----------|

$$\text{LRSI} = \text{V1}$$

$$\text{LRSI} = 0.3$$

Relative Habitat Area calculations

Total project area: 74.5 acres; Suitable Habitat area: 57.95 acres (EW + Rip S/S)

EW: 39.42 acres

Rip S/S: 18.53 acres

Grassland: 16.6 acres (non-suitable)

Relative area of EW: 39.42 divided by 57.95 = 0.68

Relative area of Rip S/S: 18.53 divided by 57.95 = 0.32

Equivalent Optimum Area calculations (relative area x LRSI) x 100

EW

REPRO: $(0.68 \times \text{NA}) \times 100 = 0$

WINTER COVER: $(0.68 \times 0.015) \times 100 = 1.02$

WINTER FOOD: $(0.68 \times \text{NA}) \times 100 = 0$

Rip S/S

REPRO: $(0.32 \times 0.51) \times 100 = 16.32$

WINTER COVER: $(0.32 \times 0.68) \times 100 = 21.76$

WINTER FOOD: $(0.32 \times 0.3) \times 100 = 9.6$

| | REPRO | WINTER COVER | WINTER FOOD |
|----------------|--------------|---------------------|--------------------|
| <u>EW</u> | 0 | 1.02 | 0 |
| <u>Rip S/S</u> | 16.32 | 21.76 | 9.6 |
| Total: | 16.32 | 22.78 | 9.6 |
| EOA SI: | 0.2 | 0.76 | 0.19 |

HSI = min of LR EOAs

HSI = 0.19

HUs = HSI x Acres of suitable habitat

HUs = 0.19 x 57.95

HUs = 11.01

Note: the EOA SIs are based on the SI graphs for the LRs

Becker Property - California Quail

FOOD1 (Agland) - NA

FOOD2 (Rip S/S)

| | | |
|---------------------------|-----------|-----------|
| V3 - Dist to escape cover | 0 m | SI = 1.0 |
| V2 - Dist to roost cover | 0 m | SI = 1.0 |
| V1 - % cover of herbs | | SI = 0.76 |
| RSS1 60 % | SI = 1.0 | |
| RSS2 13 % | SI = 0.52 | |

$$\text{LRSI} = (\text{V1} \times 0.75) \times \text{min of V2 or V3}$$

$$\text{LRSI} = 0.57$$

FOOD2 (Grassland)

| | | |
|---------------------------|----------------|-----------|
| V3 - Dist to escape cover | 503 ft (168 m) | SI = 0 |
| V2 - Dist to roost cover | 503 ft (168 m) | SI = 1.0 |
| V1 - % cover of herbs | 76 % | SI = 0.96 |

$$\text{LRSI} = (\text{V1} \times 0.75) \times \text{min of V2 or V3}$$

$$\text{LRSI} = 0$$

ESCAPE COVER (Rip S/S)

| | | |
|----------------------------------|-----------|-----------|
| V5 - Dist to roost cover | 0 m | SI = 1.0 |
| V1 - % cover of herbs | | SI = 0.63 |
| RSS1 60 % | SI = 1.0 | |
| RSS2 13 % | SI = 0.26 | |
| V3 - % shrub cover (live & dead) | | SI = 1.0 |
| RSS1 43/150 ft = 29 % | SI = 1.0 | |
| RSS2 366/450 ft = 81 % | SI = 1.0 | |
| V2 - ave. ht. of herbs | | SI = 0.34 |
| RSS1 50.8 cm | SI = 0.67 | |
| RSS2 9.2 cm | SI = 0 | |
| V4 - ave. ht of shrubs | | SI = 1.0 |
| RSS1 46.6/24 = 1.94 m | SI = 1.0 | |
| RSS2 118.6/56 = 2.12 m | SI = 1.0 | |

$$\text{LRSI} = \text{V5} \times \text{max of } (\text{V1} \times \text{V2})^{1/2} \text{ or } (\text{V3} \times \text{V4})^{1/2}$$

$$\text{LRSI} = \text{V5} \times \text{max of 0.46 or 1.0}$$

$$\text{LRSI} = 1.0$$

ESCAPE COVER (Grassland)

| | | |
|----------------------------------|----------------|----------|
| V5 – Dist to roost cover | 503 ft (168 m) | SI = 1.0 |
| V1 - % cover of herbs | 76 % | SI = 1.0 |
| V3 - % shrub cover (live & dead) | 0 | SI = 0 |
| V2 – ave. ht. of herbs | 13 cm | SI = 0 |
| V4 – ave. ht of shrubs | 0 | SI = 0 |

$$\text{LRSI} = \text{V5} \times \max \text{ of } (\text{V1} \times \text{V2})^{1/2} \text{ or } (\text{V3} \times \text{V4})^{1/2}$$

$$\text{LRSI} = 1.0 \times \max \text{ of } 0 \text{ or } 0$$

$$\text{LRSI} = 0$$

WINTER ROOST (Rip S/S)

| | | |
|-----------------------------------|----------|----------|
| V3 – dist to escape cover | 0 m | SI = 1.0 |
| V1 - % shrub cover | | SI = 1.0 |
| RSS1 29 % | SI = 1.0 | |
| RSS2 81 % | SI = 1.0 | |
| V2 – ave. shrub ht. (live & dead) | | SI = 1.0 |
| RSS1 1.94 m | SI = 1.0 | |
| RSS2 2.12 m | SI = 1.0 | |

$$\text{LRSI} = (\text{V1} \times \text{V2})^{1/2} \times \text{V3}$$

$$\text{LRSI} = 1.0$$

Relative Habitat Area calculations

Total project area: 74.5 acres; Suitable Habitat area: 35.13 acres (Rip. S/S + Grassland)

Emergent Wet: 39.42 acres

Rip S/S: 18.53 acres

Grassland: 16.6 acres

Relative area of Rip S/S: 18.53 divided by 35.13 = 0.527

Relative area of Grassland: 16.6 divided by 35.13 = 0.473

Equivalent Optimum Area calculations (relative area x LRSI) x 100**Emergent Wetland – NA (Not suitable habitat)****Rip S/S**

$$\text{FOOD2: } (0.527 \times 0.57) \times 100 = 30.0$$

$$\text{ESCAPE COVER: } (0.527 \times 1.0) \times 100 = 52.7$$

$$\text{WINTER ROOST: } (0.527 \times 1.0) \times 100 = 52.7$$

Grassland

FOOD2: $(0.473 \times 0) \times 100 = 0$

ESCAPE COVER: $(0.473 \times 0) \times 100 = 0$

WINTER ROOST: $(0.473 \times \text{NA}) \times 100 = 0$

| | | FOOD | ESCAPE COVER | WINTER ROOST |
|------------------|----|-------------|---------------------|---------------------|
| <u>Rip S/S</u> | | 30 | 52.7 | 52.7 |
| <u>Grassland</u> | 0 | | 0 | 0 |
| Total: | 30 | | 52.7 | 52.7 |
| EOA SI: | | 0.75 | 1.0 | 1.0 |

HSI = min of LR EOAs

HSI = 0.75

HUs = HSI x Acres of suitable habitat

HUs = 0.75×35.13

HUs = 26.35

Note: the EOA SIs are based on the SI graphs for the LRs

Becker Property - Yellow Warbler

RSS1

V1 - % shrub cover (live) 35/150 ft = 23 % SI = 0.38
V2 - ave. ht. of shrubs 37.5/18 = 2.08 m SI = 1.0
V3 - % hydrophytic shrubs 100 % SI = 1.0

$$\begin{aligned} \text{HSI} &= (V1 \times V2 \times V3)^{1/2} \\ \text{HSI} &= (0.38 \times 1.0 \times 1.0)^{1/2} \\ \text{HSI} &= 0.62 \end{aligned}$$

RSS2

V1 - % shrub cover (live) 348/450 ft = 77 % SI = 1.0
V2 - ave. ht. of shrubs 100.3/46 = 2.18 m SI = 1.0
V3 - % hydrophytic shrubs 100 % SI = 1.0

$$\begin{aligned} \text{HSI} &= (V1 \times V2 \times V3)^{1/2} \\ \text{HSI} &= (1.0)^{1/2} \\ \text{HSI} &= 1.0 \end{aligned}$$

Overall HSI = ave. HSI of RSS1 and RSS2
Overall HSI = 0.81

HUs = HSI x 18.53 acres
HUs = 0.81 x 18.53

$$\text{HUs} = 15.0$$

Note: RSS1 = Rip S/S Transect #1 and RSS2 = Rip S/S Transect #2